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Towards a Framework for Assessing the Sustainability of Supply Chains: the case of potatoes in Britain

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ABSTRACT

The sustainability of the fresh potato supply chain in Britain

There is growing concern about the sustainability of food production and marketing systems when measured against a set of sometimes conflicting economic, environmental and social criteria. In this context, this research aims to develop and apply a framework to assess the sustainability of fresh produce supply chains, from farm to retail outlet, using British fresh potato production and marketing as a case study.

Following a review of relevant literature, in-depth interviews were carried out with farmers, merchants and retailers to explore perceptions of the sustainability of the fresh potato supply chain over the last decade. After this, the research adopted quantitative and qualitative methods of investigation.

An attempt was made to measure the changes in the performance of the fresh potato supply chain between 1990 and 2000 in an objective manner, using thirteen sustainability (economic, environmental and social) indicators. However, the degree of the sustainability of the supply chain was measured only for 2000, because of a considerable lack of available data for 1990. Thus it was not feasible to draw conclusions on the changes of supply chain sustainability over the last decade. It was shown that the farm stage was responsible for most of the emissions to the environment and water consumption in 2000. Most of the energy was consumed at the farm and merchant stages, while the merchant stage was the most labour intensive in the supply chain.

A questionnaire survey of 240 farmers, 17 merchants and 4 retailers was carried out to elicit their perceptions of the importance of selected sustainability factors influencing supply chain performance, the changes in business sustainability during the last decade, and the future of the fresh potato supply chain.

The participants perceived that their business profitability has either been stable or decreased, while cost efficiency and environmental and social performance have

improved. During the last 10 years, economic factors have been the key drivers for change in the supply chain, however environmental and social issues have increased in importance and are likely to do so in the future. The participants perceived that major retailers, driven by the fierce competition at the retail stage where the power base for the supply chain appears to lie, have promoted actions to improve aspects of the sustainability of the whole fresh produce supply chain, such as farm assurance schemes.

This study confirmed that it is feasible to develop an approach to assess the sustainability of fresh produce supply chains over time. These sustainability indicators could be further developed and applied in the fresh potato supply chain on a regular basis in the future to provide an ongoing monitoring and evaluation of the changes in the supply chain performance in an objective manner. The developed approach could also be applied on other fresh vegetables supply chains. The study concludes that it is in the collective interest of all participants in the fresh potato supply chain to find ways to improve its economic, social and environmental performance.

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LIST OF ABBREVIATIONS

BPC	British Potato Council
CM	Category Management
DEFRA	Department of Environment, Food and Rural Affairs
DETR	Department of Environment, Transport and Regions
DPSIR	Driver-Pressure-State-Impact-Response (framework)
EC	European Community
ECR	Efficient Consumer Response
EEA	European Environmental Agency
ESA	Environmental Sensitive Areas
EU	European Union
FAS	Farm Assurance Schemes
FAS	Farm Assurance Schemes
GMOs	Genetically Modified Organisations
HACCP	Hazard Analysis of Critical Control Point
ICM	Integrated Crop Management
IPM	Integrated Pest Management
LCA	Life Cycle Assessment
MAFF	Ministry of Agriculture, Food and Fishery
OECD	Organisation for Economic Cooperation and Development
PCFFF	The Policy Commission on the Future of Farming and Food
PMB	Potato Marketing Board
PSR	Pressure-State-Response (framework)
SAC	Scottish Agriculture College
SCM	Supply Chain Management
SD	Sustainable Development
SDRs	Sustainable Development Records
SMEs	Small and Medium Enterprises
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UKDoE	UK Department of Environment
UNCSD	United Nations Committee of Sustainable Development

CHAPTER 1

INTRODUCTION

1.1. Introduction

This chapter deals with the background, the aim and objectives of the study. The structure of this thesis is also presented at the end of this chapter.

1.2. Background

The production and distribution of food products, including fresh vegetables, in adequate quantity and quality has always been an issue of vital importance for all human communities. However, there is an increasing debate at both international and national level about the negative impacts of human activities, in general, on the environment and society. The concept of sustainable development claims that the maintenance of high and stable levels of economic growth and employment may go hand in hand with social progress that recognises the needs for everyone, effective protection of the environment and prudent use of natural resources (DETR, 1998a).

The economic, environmental and social aspects (sustainability) of the production of food products, including fresh vegetables, has also attracted the attention of the society as a whole, because of, among other reasons, the extensive use of agro-chemicals and of the fact that agriculture accounts for a great part of significant environmental pollution incidents, especially in water resources, and it also plays a very important role in the structure and well-being of rural communities (Plowden, 1996; Skinner et al, 1997; Jongen and Meerdink, 1998; MAFF, 2000; PCFFF, 2002). In fact MAFF (now DEFRA), regularly, measure and report the level of sustainability of UK agriculture at national level (MAFF, 2000).

Additionally, the people and companies involved in food supply chain which produces and delivers food products to consumers, coupled with the government, increasingly attempt to assess and improve the economic, environmental and social performance (sustainability) of the food supply chain (Blonk et al, 1997; Sainsbury, 1999, DEFRA, 2001). In the last decade or so the UK food supply chain has become very highly vertically co-ordinated with very strong ties among participants (Lavelle, 1996). Those engaged in the food supply chain, are no longer seen as units in a competitive battle, but it is supply chains which now compete each other (Christopher, 1998; van Hoek, 1998).

Given the importance of food supply as an economic activity and the increasing integration of food supply chains, it is important and relevant to study the sustainability of the whole food supply chain. It is also important to identify the factors that determine its level of sustainability. Research to-date has focused either on assessing the economic and financial performance of supply chains, in general, (Beamon, 1998; 1999) or aspects of the sustainability of single stages (Andreoli and Tellarini, 2000; Vickery and Lohr, 1997). Thus, there is lack of information about the sustainability of the whole food supply chain and the factors that influence it.

1.3. Aim and Objectives of the Study

The broad aim of the study is to develop and apply a framework for assessing the sustainability of fresh vegetables chain over time using potatoes as 'case study'. In particular, this research aims to develop a set of key sustainable (environmental, economical and social) indicators to assess the performance of the supply chain, with a view to identify the changes in terms of sustainability during the last decade. Moreover, it aims to search for the relative importance of the factors that influence the behaviour of the people and businesses engaged in the supply chain in terms of sustainability over time.

The fresh potato supply chain has been selected as case study to focus the research because it is among the most important vegetables for the British diet and

agriculture. Fresh potatoes account for 22% of the consumer expenditure on fresh vegetables, with retail sales of £995m in 1997 (Strak, 1998). This study focuses on the fresh potatoes for use in homes, which accounted for more than 34% of the total potatoes used in the UK in 1998/1999 for human consumption (Rickard, 2000).

This study aims to answer a number of key questions:

- Is it possible to measure the sustainability of the fresh vegetables supply chain? If yes, what are the relevant quantitative and qualitative measurements to assess sustainability, and in particular of the fresh potato supply chain?
- What has been the change in the performance of fresh potato supply chain during the last decade according to the relevant quantitative and qualitative sustainability measurements?
- What factors have influenced the changes in the performance of fresh potato supply chain in terms of sustainability during the last decade?
- What actions can be taken to improve the sustainability of the fresh potato supply chain in the next decade and by whom?

The sustainability of fresh potato supply chain is aimed to be assessed over a relevant time period because sustainable development is a dynamic rather than a static concept. Society's expectations from the performance of food supply chain in terms of sustainable criteria are changing over time. Additionally, it is difficult to determine absolute degree of sustainability. The time period of 1990-2000 has been chosen in this study because it is perceived that important changes have taken place in fresh vegetables supply chain in terms of sustainability during that period (Lavelle, 1996; Wilson, 1996b; Croner 1998a; Falkoner, 2000).

While the study focuses on potatoes, it is anticipated that the outcomes will provide important insights of relevance to fresh vegetables and food supply chains, in general.

1.4. Structure of Thesis

The thesis is divided in nine chapters. Chapter 1 is an introduction including background, aim and objectives of the present study and the structure of the thesis. The definition of the study topic and the sustainability assessment of fresh vegetables supply chain are reviewed and discussed in Chapter 2. Chapter 3 illustrates the general methodology of the study. Chapter 4 shows and discusses the findings from the in-depth interviews with farmers, merchants, retailer representative and consumers about the sustainability of fresh potato supply chains during the last decade. Chapters 5, 6 and 7 contain the results from qualitative surveys undertaken with farmers, merchants and retailers, respectively. These chapters dealt with the changes in the performance of fresh potato supply chain according to selected qualitative economic, environmental and social indicators during the last decade, and the reasons that were behind these changes. Conclusions and recommendations emerging from the study are covered in Chapter 8.

CHAPTER 2

MEASURING THE SUSTAINABILITY OF FRESH POTATO SUPPLY CHAIN

2.1. Introduction

This chapter defines the study topic and the boundary of the enquiry. Initially, it deals with the concepts of sustainable development and supply chain management and the importance of the fresh potato supply chain. The methods and models developed so far to measure the sustainability either of the whole supply chain or of single stage are then reported. This chapter also covers the main changes that have taken place in the supply chain of fresh vegetables, and in particular of fresh potatoes, and have influenced its sustainability during the last decade, using information derived from multiple sources.

2.2. Definition and Key Objectives of Sustainable Development (S.D.)

Sustainable Development has been an issue of increasing importance around the world for the last two decades, in response to concern about deteriorating environmental conditions in many parts of the world (Bossel, 1999). Bell and Morse (1999) also mention that '*if one listens to speeches by politicians or reads articles by economists, policy makers or scientists the word sustainable appears with a remarkable regularity*'. Sustainable development is also a key issue for the agriculture sector and food supply chain in general, as mentioned before, and the UK government has set as a target the improvement of the sustainability (economic, environmental and social aspects) of food supply chain (MAFF, 2000; PCFFF, 2002).

There are many definitions of sustainable development. The commonly used definition is '*development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs*' given by the

UN sponsored World Commission on Environment and Development (WCED, 1987) in its report *Our Common Future*. However, it is impossible to satisfactorily define reasonable or acceptable standards for human life. According also to IUCN (1991) sustainable development is the 'development that improves the quality of human life while living within the capacity of supporting ecosystems'. However, it is difficult to objectively define and evaluate the 'capacity of supporting ecosystems'. Pearce and Barbier (1989) argued that 'the alternative approach [to sustainable development] is to focus on natural capital assets and suggest that they should not decline through time'. But this approach does not identify goals and focuses only on physical and ecological constraints (Perman et al, 1998). For this reason, sustainable development has been described as '...maximizing the net benefits of economic development, subject to maintaining the services and quality of natural resources over time' (Bell and Morse, 1999). However, the requirement that the services and quality of natural resources be maintained over time is ambiguous. Thus, although, definitions may be attractive because of their simplicity, they are often criticised because they are vague and allow various and different interpretations. A set of key objectives seems to be more useful to better understand and guide the implementation of sustainable development.

In this context, the UK Department of the Environment, Transport and the Regions (DETR, 1998b) seeks to attain sustainable development based on four broad objectives:

- Maintenance of high and stable levels of economic growth and employment;
- Effective protection of the environment;
- Prudent use of natural resources; and
- Social progress which recognises the needs of everyone.

Sustainable development is about ensuring that some of human well-being is sustained over time. However, this human sustainable well being refers not only to present generations but extends as well to the future ones. According to the economists the most appropriate measure in this case is the capital of a society or a nation. Capital comprises (Turner, 1995; Rao, 2000):

- Man-made capital, based on manufacturing or related economic activities, such as housing and roads;

- Natural capital, such as non-renewable and renewable natural resources, biological diversity, clean air and water;

- Human capital, such as knowledge, skills and health; and

- Social (ethical) capital, consisting of culture and ethical values, people's institutions, efficacy and quality of institutions, cooperative behaviour, trust, social norms, and people's participation in decision making.

Thus, sustainable development has three dimensions, namely economic, environmental and social and the relative importance of each component depends on the form of sustainability adopted. At the one side of the sustainability spectrum lie those that prefer the strong form of sustainability, who are concerned more on the prudent use of natural resources and protection of the environment than attaining high economic benefits (Turner, 1995). According to this approach, we should not protect just the overall stock of capital, rather the level of natural, human and social capital, as at least some of natural, human, or social capital is not substitutable. Thus, the strong form of sustainability viewpoint requires that the natural, human and social capitals are constant, and moreover they are monitored and measured via appropriate indicators (Turner, 1995).

At the other side are those adopting the weak form of sustainability who emphasise more on economic aspects than on environmental and social. Weak sustainability equates to a sort of economic sustainability where the emphasis is upon allocation of resources and levels of consumption, and financial value is a key element of system quality (Hediger, 2000; Bell and Morse, 1999). Weak sustainability for example, allows natural capital to be substituted by elements of man-made capital, for example, replacing natural forest with managed forests.

2.3. Food Supply Chain Management (S.C.M.)

This study aims to study the sustainability of the fresh vegetables supply chain than single stages of it because one of the most fundamental changes that have taken place in the food supply chain in the last 10 to 15 years has been the greater integration of the relationship between farmers, merchants and retailers (Lavelle, 1996). Thus, the food supply chain could be defined as the co-operation between farmers, merchants (or manufactures) and retailers in order to deliver wholesome food products to consumers. In fact, in the last decade or so there has been repositioning and redesign from production-driven supply chain to market-driven supply chain (Folkerts et al, 1998). Moreover, the UK Food Safety Act of 1990 and its 'due diligence' clause has encouraged closer relations among the actors in the food supply chain (Wilson and Lavelle, 1996). Christopher (1998) and van Hoek (1998) also argue that companies are no longer the units in the competitive battle, but it is supply chains which compete each other.

The concept of Supply Chain Management is concerned with the linkages in the chain from the primary producer to final consumer with the incentive of reducing the transaction costs incurred within it (Gattorna and Walters, 1996; Harland, 1996; van der Vorst et al, 1998). It aims to provide higher levels of service and substantial savings in costs by reducing the barriers between the players of the supply chain (Wilson, 1996b). Enhanced S.C.M. reduces the risks in food safety generated from the production, processing and distribution of foodstuffs.

S.C.M. has developed rapidly the last decade, especially in the food supply chain because it enables the players to synergise their strengths to supply and develop the market better. S.C.M. can improve the stability of prices/returns, provide better financial returns, improve each actor's ability to supply what the market requires and provide economies of scale and marketing support. S.C.M. is based on the trust and good relationships between the players in the supply chain. This reduces transaction costs as it reduces the need for contracts and expensive negotiations. Moreover, the needs of consumers are better met since more information is available to every actor, and Research & Product Development is better co-ordinated (Wilson, 1996a).

However, in some cases, some actors of the supply chain have much greater power than some others and may try to absorb as much as possible the benefits of the synergetic actions. Co-operation will last as long as there is a mutually exclusive competitive advantage. Moreover, although the actors of the supply chain may have common strategies, their goals and objectives may be different giving rise to potential conflict. This is especially the case if power and influence is unequally distributed among the participants in the supply chain (Wilson, 1996a).

2.4. Fresh Potato Supply Chain in the Last 10 Years

Potato is perhaps the vegetable used most in the diet of British people. The value of the UK fruit and vegetables market reached £11.74 billion in 1998 while fresh produce accounted for more than 60% of all sales in 1998 (Key Note, 1999a). Fresh potatoes account for 22% of the money spent for fresh vegetables (Anonymous, 1998b), with retail sales of £995m in 1997 (Strak, 1998). UK is self sufficient in potatoes at the level of 85-87%. Imports, account for 13-15%, two thirds of which are processed (raw equivalents). Consequently, more than 90% of fresh potatoes that reaches at the British consumer come from the UK (PMB, 1997; Anonymous, 1998b). The above-mentioned statistics, which highlight the great importance of fresh potatoes to the British diet and to the food industry, played a key role in choosing fresh potato supply chain as a case study for studying the sustainability of fresh vegetables supply chain.

During the last decade very significant changes have taken place in the fresh potato supply chain. The co-ordination between the participants of the food supply chain is far higher than 10 years ago and major retailers have acquired dominant negotiation power, which allowed them to drive the changes in the supply chain (Lavelle, 1996). Moreover, legislation in terms of food safety and environmental protection has been significantly stricter (Wilson, 1996b; Croner 1998a) and the British Government and the E.U. have given incentives to farmers to adopt environmental friendly production systems (Falkoner, 2000). Some major retailers set as pre-requisite that UK fresh vegetables are produced under farm assurance schemes (Tesco, 2001e; Sainsbury's, 2000). Increased consumer awareness of food safety, quality, and

environmental and ethical issues has also triggered significant changes in the food supply chain (Hughes D. et al, 2000).

2.5. Sustainable Development Measures

Assessing the sustainability of fresh potato supply chain requires, among other things, reliable information about the state of the supply chain with regard to relevant economical, environmental and societal issues and the factors that impact on them (Pearce, 1993; Pearce and Barbier, 2000; Rao, 2000). This can be done by using appropriate sustainability indicators in order to simplify and quantify the information so that this to be easily communicated to those concerned (UKDoE, 1997; Bossel, 1999; Moffat et al, 1999).

Sustainable Development is also a very complex concept because there are many interactions between economic, environmental and social capital. Thus, an indicators framework is essential in order to have an overview of these links and consider the issues in a systematic way, and also ensure that important issues have not been overlooked (DETR, 2000; UKDoE, 1997).

Classification of sustainability indicators is also important in order to select the most appropriate indicators according to the objectives of this study (Young and Welford, 1998). Sustainable Development Records and Eco-Compass, presented in this section, are two analytical methods to assess the sustainability of the fresh vegetables supply chain according to key indicators (Nilsson et al, 1995, Bennett et al, 1999).

2.5.1. Indicators of sustainable development

Indicators of sustainable development are mainly used: to monitor consumption or transformation (of materials or energy); to monitor the consequences of consumption or transformation (e.g. pollution, climate change); to compare states or trends between localities or countries; to set targets (e.g. reduction of greenhouse gas emissions); and to

provide a component of an integrated measure of environmental, economic and social issues (UKDoE, 1997).

However, indicators have some significant limitations, as they are by their nature simplifications. Moreover, although they are useful in areas that can be quantified and given meaningful statistics, they are less useful for some very valuable sustainable qualities that can not be quantified, like relationships in the supply chain. Another limitation comes from the inability or difficulty to measure sometimes all environmental, social and economic aspects of sustainable development on a common basis, such as monetary valuation. Thus, although indicators can help to measure both environmental and economic change, they cannot always play significant role in the reconciliation of the two aspects (UKDoE, 1997).

UKDoE (1997) mentions a list of traits that a good indicator of sustainable development should have. The most important of which are to: be representative; be scientifically valid; be simple and easy to interpret; show trends over time; be based on readily available data or be available at reasonable cost, which are adequately documented and of known quality; have a target of being updated at regular intervals; and have a target level or guideline against which to compare it.

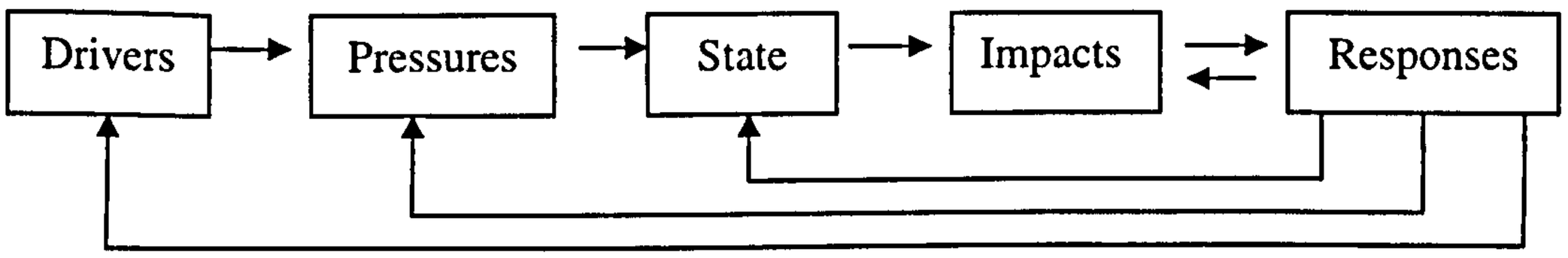
Another criterion in choosing the final set of indicators is that they are balanced as more as possible in terms of the coverage and representation of the issues. Moreover, it is important to select a limited number of indicators, so that the main issues are highlighted without the risk of oversimplification of reality (UKDoE, 1997).

2.5.2. The indicators framework

There is no international consensus on a particular indicators framework for sustainable development, however, some models have been proposed, particularly for environmental indicators (DETR, 2000). The PSR 'pressure-state-response' framework initially developed by OECD (1997) is the most well known and was used by the United Nations Commission for Sustainable Development (UNCSD) to develop a framework of sustainable development indicators (DETR, 2000).

The European Environment Agency has adapted the PSR framework into DPSIR 'driving forces-pressures-state-impact-response' model (Figure 2.1) (EEA, 1998; 1999). Its concept is that economic and social developments (like human demands from industry, agriculture) are Drivers that exert Pressures on the environment (emissions to air, water and soil, water consumption, etc) and change its State in terms of quality and quantity of natural resources (e.g. CO_2 in the air, water resources etc). This leads to Impacts on human health, ecosystems and materials (global warming, human living standards, etc). Finally, there may be societal Responses (e.g. green taxes, stricter environmental regulations, etc) that feed back on the Driving forces, or on the Pressured or State or Impacts directly, through adaptation or curative action.

Figure 2.1: The DPSIR framework for reporting on environmental issues



Source: EEA, 1998; 1999

The PSR and DPSIR frameworks can help in understanding the interconnections between environmental and socio-economic aspects, but they are not entirely appropriate for dealing with sustainable development (DETR, 2000). For example, according to both PSR and DPSIR frameworks consumers' demand for higher quality, more convenient and cheaper food products would be regarded as driving force that exert pressures on the environment and have also social and economic impacts. However, the underlying driver is not merely consumers' desire for food products that meet these criteria, but the major changes that took place in society during the last decades coupled with the advance in technologies that allowed the food supply chain to offer such products to consumers. Moreover, the PSR and DPSIR frameworks do not readily refer to issues like relationships between the partners of the food supply chain. Thus, these frameworks can be used as an analytical tool to have an overview of

environmental, social and economic links and consider these issues (driving forces, pressures, change in the state, impacts and responses) in the context of food supply in a systematic way.

2.5.3. Typology of SD indicators

After choosing an indicator framework it is also very important to select the most appropriate indicators to measure sustainable development. There are several classifications of indicators according to the level of data measurement or their purpose. Young and Welford (1998) classify environmental indicators as following:

- Absolute Indicators: They measure basic data, like carbon dioxide emissions and total energy or water consumption.

- Relative Indicators: They compare absolute consumption or emission figures to some other relevant parameter, like units of production. The relative indicators an be separated into:

  - *Efficiency Ratios:* They measure how efficiently the resources have been used for the production per unit or the amount of emissions in relation to inputs or outputs. For example, water consumption or total amount of fertilisers used per kg of potatoes produced.

  - *Quotas:* They describe the proportion of a measure in relation to the total measure. For example, the proportion of very dangerous wastes in relation to the farm's total wastes.

- Aggregated Indicators: They put together data from specific indicators into a more general indicator. For example, the annual energy consumption may derive from the energy used for the production, packaging and storing the product. Thus, aggregated indicators are useful in assessing the performance of the whole supply chain. In some cases, weightings are used in order to get more meaningful results from aggregated indicators. However, weighting suffers from reliability because it is to

some extent subjective and the judgement on the relative importance of each component may vary significantly from person to person (Werhmeyer, 1995).

- Index Indicators: They are comparisons of a piece of data to another baseline piece of data. The same authors, however, claimed that they found indexing difficult and potentially statistically uncertain and hiding detail (Young and Welford, 1998).

The EEA has also developed a typology of environmental indicators, which classifies them in 4 categories (EEA, 1999). Type A consists of descriptive indicators, which describe the actual situation with regard to the main environmental issues, such as climate change or wastes in relation to the geographical levels at which these issues manifest themselves. Type B includes performance indicators, which compare actual conditions with a specific set of reference conditions. Type C consists of efficiency indicators, which illustrate the efficiency of production or consumption processes, while type D includes total welfare indicators, which provide a measure of total sustainability and illustrate whether, overall, welfare is increasing. The EEA typology had been developed for environmental reporting at national or local level. However, performance and efficiency indicators are commonly used in companies' environmental reports (Sainsbury, 1998a).

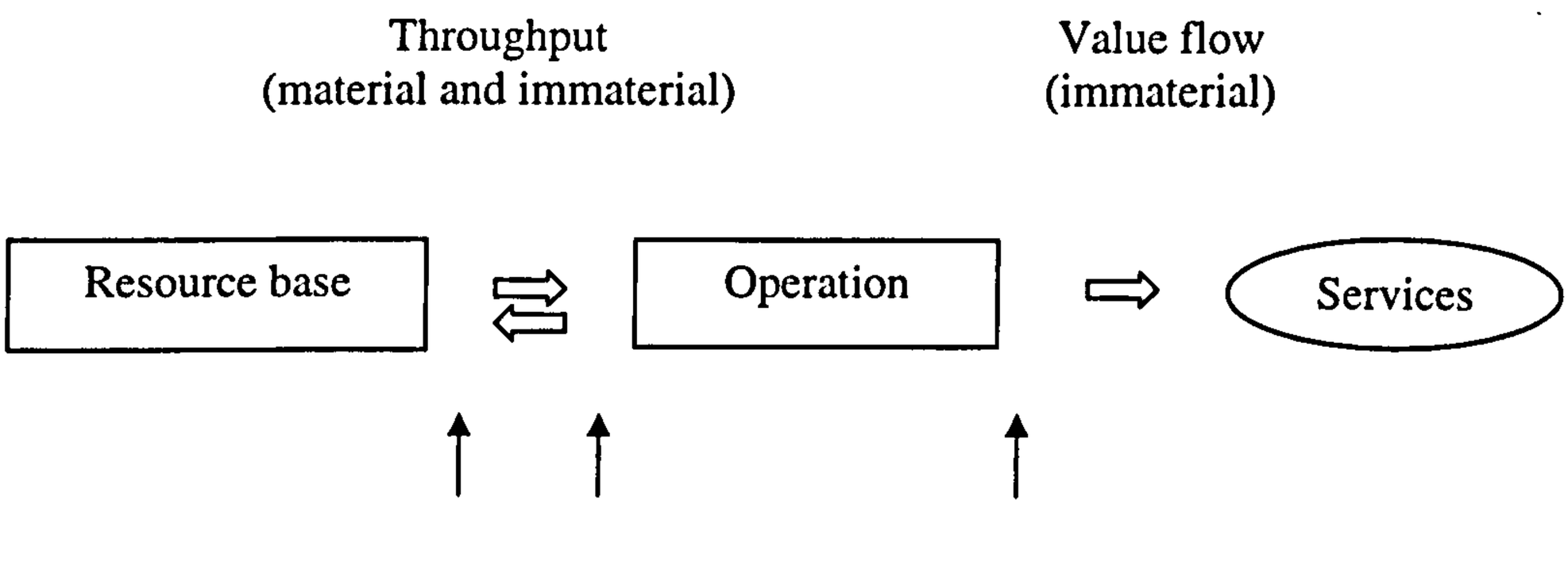
From the above-mentioned list of indicator types, efficiency indicators, which measure the efficiency of the supply chain, and aggregated indicators, which put together data from specific indicators into a general indicator, seem to be the most appropriate to address the research objectives of this study.

2.5.4. Sustainable Development Records (SDRs) and Eco- Compass

Sustainable Development Records (SDRs) comprise an analytical method able to assess the sustainability of supply chain according to key criteria (indicators) taking into account the key functions of the fresh produce supply chain. The SDR model (Nilsson et al, 1998) consists of: (1) resource base; (2) operation and (3) services (Figure 2.2). Service is defined as the satisfaction experienced when needs are satisfied.

The resource base includes the financial, environmental and social resources. The operation, in this case, consists of various kinds of services or values which are regarded as immaterial flows, such as giving higher value to the inputs in order to satisfy better the consumer needs. The throughput is comprised by both material flows, like fertilizers, packaging materials, and non-material flows, such as knowledge and money.

Figure 2.2. The Sustainable Development Records Model



Source: Nilsson et al (1995; 1998).

The SDR methodology relies on the development of key ratios, which are defined as relationships between different parts of the SDR model. The SDR ratios are a type of social and ecological indicators suitable for environmental accounting. In fact, the SDR ratios are clusters of indicators on every aspect of the operation. The SDR indicator should be a quotient with a numerator and denominator in accordance with the economic logic of the SDR analysis. Moreover, all measurement should be independent of scale (Nilsson et al, 1995).

The SDR key indicators can be distinguished by the following performance criteria (Nilsson et al, 1995):

- Effectiveness. How effective or appropriate are the services provided by the system?
- Thrift. Does the system require a modest input of material resource and energy?
- Margin. Can the inflows and outflows be sustainably maintained without impairing the resource base and essential ecological functions?

The SDR model can provide useful insight into the performance of the fresh potato supply chain performance by using selected sustainability indicators (research objective 2). However, the key indicators of this study would be better distinguished to 'efficiency' indicators, which measure the efficiency of the supply chain to deliver a tonne of fresh potatoes to consumers and 'allocation' indicators which assess the contribution of each stage of the supply chain in the volume of each indicator (e.g. what part of the total energy consumed from the supply chain is related to farmer, merchant or retailer).

Another way to analyse the data derived from sustainability indicators is the Eco-Compass, which is often used in Life Cycle Assessment (LCA), which is described below, when comparing two or more products or systems in terms of their environmental performance (Bennett et al, 1999). In the case of sustainability assessment each sustainability indicator would hold a corner of the Eco - compass. The Eco-compass could be used to monitor the direction of changes in the performance of the fresh vegetables supply chain according to selected sustainability indicators over time. The sustainable performance of a particular year is set as the 'baseline' or 'benchmark', while the difference in the performance for each sustainability indicator between the 'baseline' year and another is presented in percentage ratio. The use of the Eco-Compass can be feasible only if there is reasonably complete LCA data to give a holistic picture of the performance of the supply chain. It is a useful method to make comparisons in the performance between supply chains facilitating the communication of sustainability performance and identifying areas for attention and improvement.

2.6. Life Cycle Assessment (LCA)

Life Cycle Assessment is often used for environmental research to study a product's impacts from its 'cradle to grave'. LCA has been applied in several food chains to identify and quantify potential environmental impacts throughout the life-cycle of food products (Weidema et al, 1995; Andersson et al, 1996; Audsley et al, 1997; Blonk et al, 1997; Ceuterick, 1998). Thus, it is useful to review the main points of this approach for the purposes of this study.

The main methodological steps, the LCA phases are: goal definition and scoping, inventory analysis, impact assessment, interpretation and improvement assessment (Croner, 1998b).

Goal definition and scoping is crucial step for a successful LCA because this phase establishes, among others, the purpose and scope of the study (for example, the aim and objectives of the study); the functional unit (in this study a tonne of fresh potatoes reaching the consumer); the main delineation of the product system boundaries (in this study are the main activities that take place in the supply chain); and the level of detail required to meet the aim of the study (Croner, 1998b).

Inventory analysis is the next phase of LCA. It consists of the identification and quantification of all the inputs into and outputs from the product or system under study. The first step of inventory analysis is drawing a flow chart, the process tree, incorporating all relevant processes and steps in the system defined. Such inventory analysis would also be important for the purposes of this study in order to identify and quantify the major inputs and outputs of the activities that take place in the fresh potato supply chain

In most cases, the inventory analysis phase yields a large amount of data and thus it is difficult to interpret the results. This is followed by impact assessment which characterizes and assesses the total effects on the environment of the loadings identified in the inventory analysis. Impact assessment could also be important for the purposes of this study in order to identify the environmental impacts from the production and marketing of fresh potatoes.

At the interpretation phase the results of the preceding LCA phases are compared with the goal of the study set in the goal and scope definition. Results validation can be achieved with two approaches, which complement each other: performance of sensitivity analyses by the LCA practitioners involved; and independent, external review. At improvement assessment stage, options for improvement at the product or the process are identified and evaluated.

Difficulties commonly faced when carrying out LCA have to do with the allocation of impacts between two products of a process or between the main product and a by-product. Problems can also arise when comparing products or systems in ensuring that the comparison is like-for-like. Moreover LCA is a detailed and consequently an expensive method.

It is considered that LCA could help to quantitatively assess the sustainability of fresh potato supply chain 'from cradle to grave' in a systematic way. The principles and techniques of SDR and LCA have potential to assess sustainability, providing data can be obtained for a given part in time or over a period of time.

2.7. Sustainability Assessment of Fresh Vegetables Supply Chain

The literature review revealed that there has been no research to assess the sustainability of fresh vegetables supply chain over time. However, several models that measure supply chain performance have been developed and aspects of food supply chain relationships have been studied (Beamon, 1998; 1999; Li and O'Brien, 1999; White, 2000). Moreover, significant research has been carried out to assess the sustainability at farm level and farmers' attitudes to sustainable agriculture (Smith et al, 1998; Carr et al 1991).

2.7.1. Methods of measuring supply chain performance

Several methods and models have been developed to measure supply chain performance. The most important characteristic of all these methodologies is that they

focus the measurement of supply chains on the economic and financial elements ignoring the environmental and social issues (New, 1997). Moreover, they are focused on the manufacturing sector (Stewart, 1995; 1997; Beamon and Ware, 1998; Beamon, 1998; 1999; Li and O'Brien, 1999;) and on physical distribution logistics (Bytheway, 1995; Vidal and Goetschalckx, 1996; McGuffog, 1997; Koota and Takala, 1998), and consequently these previous approaches are insufficiently complete to assess the economic, environmental and social performance of the fresh vegetable supply chain.

Grimsdell, (1996) and Bridge (1996) mentioned six fundamental requirements for an efficient supply chain between growers and the major retail customers, some of which the author of this thesis finds that they are crucial to be taken into consideration when measuring aspects of 'business' sustainability of the supply chain: Scale of operation. The production scale in terms of volume produced should be large enough in order to achieve economies of scale. Thus, issues like the size of potato enterprise or their production costs should be considered. Strategic alliances. Producers need to establish strategic alliances with large and successful marketers in order to face the challenges of the new era of food industry. Hence, relationships among the participants in the supply chain should be positive and help smooth the flow of products and services. Production flexibility. In some cases, it is better for producers to have several contracts, which can provide some degree of flexibility, as business uncertainty is a key issue of fresh vegetables supply chain. Continuity of supply. The continuity of supply is strongly required from the major retailers. Hence, variability of quantity is an issue of great importance studying the fresh vegetables supply chain. Quality control. The UK Food Safety Act of 1990 is, to a great extent, responsible for the sensitivity that major retailers show to the issue of quality control. A producer that can demonstrate capability to meet the agreed product specifications, keep accurate records and produce safe foodstuff is favourable to strengthen its links in the supply chain and increase company's profitability in the longer term. Communications. Communications are vital for the success of all. With a better understanding of each other's needs, the actors in supply chain can improve the confidence in the people and the technology necessary to maintain competitive advantage. Thus, supply chain relationships are also a key issue to be explored.

Neely et al. (1995) concluded that although various measurement frameworks have been developed, there is not any generally applicable systematic approach to measure supply chain performance. Consequently, all previous work done on supply chain performance measurement can apply under specific conditions, which implies the necessity to develop a framework to assess the performance of fresh vegetable supply chain.

Beamon (1998 and 1999) has made a thorough review of the methods and models developed for the performance measurement of supply chain. She mentions, among others, that cost, activity time, customer responsiveness and flexibility have all been used in these models and methods singly or jointly. The single supply chain performance measures suffer from important weaknesses such as lack of inclusiveness (measure all relevant aspects), lack of universality (ability to make comparisons), and lack of measurability and consistency (with the targets of the model) (Beamon, 1999). Moreover, she states that:

> "Current supply chain performance measurement systems are inadequate because they rely heavily on the use of cost as the primary (if not sole) measure, they are not inclusive, they are often inconsistent with the strategic goals of the organisation and do not consider the effects of uncertainty."

Consequently, such methods and models cannot be easily applied in this study, which takes a broader view of supply chain performance.

New (1995) developed a simple taxonomy to classify existing examples of supply chain improvement. This taxonomy is based on specificity (the degree to which actions taken generate outcomes specific to one relationship), action/investment (who is taking the active lead), location/focus (the domain of improvement) and benefits (how the direct results from an improvement activity are divided up). Such taxonomy could also be applied for assessing the performance of fresh potato supply chain, but social or environmental related issues should also be included.

Reutterer and Kotzab (2000) used Conjoint Analysis to evaluate the preferences and expectations of supply chain managers in designing a supply chain. Conjoint analysis could also be potentially used in this study to explore the relative importance of

selected factors-attributes placed by participants on their choice for supply chain systems. However, these factors should not be more than 5 or 6, because it would be difficult for the respondents to consider all of them together (Green et al, 1988).

Hobbs and Young (2000) presented a framework that links drivers for change to product characteristics, which in turn affect transaction characteristics and transaction costs and consequently trigger changes in vertical co-ordination of supply chains. They used this framework to analyse the changes in the US grain industry. Klein et al. (1996) also developed a framework to evaluate the supply chain performance in the Canadian pork sector. Questionnaires, sent to representatives of the supply chain, elicited their opinions regarding efficient production and distribution; equitable distribution and rewards; growth in pork sector; investment opportunities; and degree of competition. Moreover, Rademakers and McKnight (1998) used quantitative data and in-depth semi-structured interviews to study the concentration and inter-firm co-operation within the Dutch potato supply chain. These frameworks do not deal with environmental and social issues and hence, they could not be readily used for the purposes of this thesis. However, they were found very useful in terms of giving insights to assess the sustainability of fresh potato supply chain during the last decade.

The literature review on the methods measuring supply chain performance revealed that there is no framework that could be applied to assess the performance of fresh vegetable supply chain according to an integrated set of economic, environmental and social criteria. However, the existing methods provided very useful insights in developing an approach to address the aim and the questions-objectives of this study.

2.7.2. Supply chain relationships

The nature of the relationships between the participants of food supply chain plays crucial role in its sustainability, which is even more obvious nowadays as the relationships of the participants are considerably closer than before (Hughes et al, 2000). Businesses also recognise that their success relies on the relationships with their partners (Hogarth-Scott, 1999). The literature review did not reveal any research on

supply chain sustainability which included relationships assessment, however, there are several studies about the relationships (mainly) between major retailers and their suppliers (Robson and Rawnsley, 2001).

Loader (1997) assessed transaction costs in a qualitative case study to describe supply chain relationships in agrifood systems and more specifically the marketing channels of Egyptian potatoes in the UK market. He presented two tables for each contractual situation (e.g. retailer-consumer, consumer-retailer), where he summarised the transaction objectives, the elements of the transaction concerned (i.e. volume of transaction; political, economical or social risk; dedicated inputs; limited judgement; and opportunistic self-interest) and the expected governance structure (i.e. implied contracting process; expected governance structure; actual governance structure; and implications and observations). He found that for import suppliers, the relative concentration of UK supermarket sector gives them the opportunity to deal with very few negotiators, thus decreasing transaction costs, which suggests that ever-closer relationships will form. However, a key-weakness of this approach is that its data collection involves very few key informants. The use of a small number of informants limits the reliability and validity of the results of the approach; however, gaining co-operation from all feasible respondents is difficult.

Hogarth-Scott (1999) studied the constructs of three types of retailer- supplier relationships in the UK food industry context. She concluded that to some extent suppliers are hostages of retailers and that it is easy to confuse satisfaction with loyalty, however, relationships will keep playing crucial role in businesses success and will need to be managed in all their diversity to create value.

Hogarth-Scott and Dapiran (1997) studied the nature of relationship concepts of power, trust and commitment in the partnerships in the UK and Australian food distribution channels. They held semi-structured interviews with trading and supply chain directors of three major UK food retailers. They found that 'in the UK there was senior level commitment and extensive cross-functional representation across organisations involved in the partnerships' and that 'CM (Category Management) partnerships were seen by some respondents as exercises in joint planning and the setting of shared objectives for the entire supply chain. These firms were focused on

breaking down traditional organisation barriers to generate benefits for retailers, suppliers and consumers.' Hence, the in-depth interviews, in general, seem to be a useful tool to select important information about the relationships in the fresh vegetable supply chain.

Duke (1998) reviewed the literature on buyer-supplier interaction in a variety of countries and industries and combined it with the knowledge on UK grocery retailing, in order to develop a model to explore the nature of relationships between retail buyer and manufacturer's representative. Initially, this model assumes that the buyer-supplier relationship can be described as being to some extent distributive (adversarial, transaction-based approaches) or integrative (co-operative or partnership approaches). He also found that, according to the literature, a wide range of factors influence the nature of buyer-supplier relationships and he organised these factors under eight headings, namely, power, nature of negotiation, personal factors, organisational factors, retailer objectives, ambient social pressure, political and government pressure, and stance of negotiating partner. Although, he argued that his model's applicability in the UK grocery retailing would face difficulties because of the asymmetrical retailer-merchant power balance, his research gave useful insights about the aspects of supply chain relationships to be studied in fresh potato supply chain.

White (2000) carried out semi-structured interviews with 14 retail senior buyers and 14 supplier senior marketing executives in order to explore the nature and perceptions of buyer-supplier relationships in the UK fresh produce industry. The findings of that survey are interesting since the sample frame represented the views of over 55% of supplies for the UK field vegetables. She concluded that buyer-supplier relationships have become less transactional in the last 10 years or so because of retailers need for continuity and volume. However, until two to three years ago retailers were financially exploitive of their bargaining power. Nowadays, these relationships are more co-operative because both sides realised that it is more beneficial for their business interests to invest in supply chain relationships. Moreover, she mentioned that 'In this sector, category management, ECR (Efficient Consumer Response) and quick response philosophies have impacted on the nature of relationship management to the point where supplier and retailer organisations are operating almost as one. Integration

and sharing of information are extensive and the implications of not being a 'preferred supplier' are enormous'. Thus, once more it is becoming clear the considerable importance of relationships between players in the sustainability assessment of fresh vegetable supply chain.

2.7.3. Sustainability assessment of agriculture

Agriculture is the one stage of the food supply chain that has been the focus of studies on sustainability (Smith et al, 1998; MAFF, 1998a; Vickery et al, 1997), hence a review on the research made on the sustainability assessment of agriculture could help to provide insights to address the aim and questions-objectives of this study.

Vickery and Lohr (1997) have made an annotated bibliography and resource list of the methods used in assessing the sustainability of agriculture. Most of these approaches, ask farmers to self-assess their farm pesticide and fertiliser management, water consumption and soil protection, which are also important aspects of fresh potatoes supply chain sustainability.

Sulser et al. (2001) have also developed a field approach for assessing biophysical sustainability of alternative agricultural systems. They use a questionnaire consisting of 5 point Likert rating questions, which is addressed to groups that include farmers and others with extensive working and managing experience in agricultural production, asking from them to self-assess the performance of each alternative system. Thus, this model can quantify environmental or social and economic impacts, but it is difficult to objectively observe trends over time.

Andreoli and Tellarini (2000) presented two types of methodologies to evaluate farm sustainability. The first methodology transforms initial data of farm performance in terms of economic, ecological, environmental, psychological, physiognomic and social criteria, into utility values, which are processed by techniques like multiple criteria analysis. However, it is a methodology whose reliability is subject to the accuracy of the weightings of each utility made. The second methodology, less sophisticated than the first, transforms initial data on the basis of quartiles and then

sums them up without weighting. The authors use data derived from the Italian Network of Farm Accountancy (RICA) to rank farms according to their total score and divide them into four classes. However, it seems to be rather subjective to achieve an overall judgement of farm sustainability using such indices derived from summing up methods. The lack of reliability and objectiveness make these two types of methodologies to seem to be inappropriate for the aim of this study.

Tellarini and Caporali (2000) presented an input/output methodology to evaluate farms as sustainable agro-ecosystems. They developed a range of agro-ecosystem performance indicators to measure the fundamental energy transfers between agro-ecosystem components and also measure the overall efficiency of farm transforming external inputs to outputs. However, they found that energy and monetary values do not offer a single, coherent account of agro-ecosystem sustainability at farm level. This may imply that it is more appropriate to look for trends of supply chain sustainability over time according to selected indicators than trying to create a single measurement of sustainability.

Moreover, Callens and Tyteca (1999) aimed to assess the sustainability of firms based on the concepts of cost-benefit analysis and the principles of productivity efficiency. The challenge of such models is that they try to maximise the benefits minimising costs and thus they are rather demanding in data collection. Webster (1999) also stresses the dangers of optimisation models, which derive from the fact that the omitted variables lead to biases in the decision variables and that such models can become very complex, raising difficulties for other to fully comprehend the assumptions and easily appraise the results. Thus, such concepts and models seem inappropriate for the research objectives of this study because they are too complex and complicated.

Lewis et al. (1999) developed a software package that estimates emissions generated on farm. The development of emissions inventory is very important and helpful to achieve sustainability at farm level, but it covers, though comprehensive, only a part of sustainability assessment. Thus, this research may, however, provide useful insights to estimate emissions generated by the food supply chain at the farm stage.

Pretty (1998) also studied the transition towards modern agriculture in terms of environmental issues and the status of sustainable agriculture in Europe. He also suggested a list of 10 classes of indicators to assess the transition to sustainable agriculture at national level. These key indicators consist of: pesticides; fertilisers; soils; energy; water; wastes; wildlife; local innovations; local community; and partnerships and learning. Some of these indicators, such as pesticides, fertilisers, energy and water are also relevant to the aim and objectives of this study.

MAFF (2000) has also attempted to measure the level of the sustainability of the UK agriculture using a list of 35 indicators, focusing on the key issues for sustainable agriculture and taking account of data availability. The indicators have been grouped under the following headings:

- Agriculture within the rural economy and society, which deal with the structure of the agriculture industry, farm financial resources, and agricultural productivity and employment.

- Farm management systems, which includes farm management, organic farming and codes of practice indicators.

- Input use, consisting of pesticide use, nutrients, greenhouse gas emissions and energy aspects of agriculture.

- Resource use, dealing with water, soil, agricultural land and non-food crops issues

- Conservation value of agricultural land, which consists of landscape, habitats and biodiversity indicators.

The data published in that report give a comprehensive overview of the sustainability of the UK agriculture, however, they do not include information about individual agricultural sectors such as vegetables or potatoes that would be of interest for this study. Moreover, MAFF aims to make an overall assessment of the sustainability of UK agriculture and not of a particular product supply chain. Thus, most of these 35 indicators would not be appropriate for this study that aims to capture the main trends of fresh potato supply chain over time because it would need enormous

effort and time to select such data. However, several of these indicators, such as agricultural employment, pesticide leaching, energy and water consumption, nitrate and phosphorous losses, and ammonia emissions, are relevant to this study and provided very useful insights.

Concluding, the existing methodologies on assessing the sustainability of agriculture, though, they are considering in most cases the three elements of sustainable development, namely economic, environmental and social, seem that they perceive that agriculture is an isolated industry and not part of the food supply chain, whose main aim is to meet consumers demands for foodstuffs. Thus, most of these methodologies aim either to maximise 'benefits' and minimise 'costs' of sustainable agriculture or to establish an index of sustainability using subjective weighting systems in order to compare various agro-ecosystems. However, these methodologies do not include some very important issues of sustainable agriculture such as relationships of farmers with their partners in the supply chain and retailers' requirements for continuous supply of high quality and of competitively priced food products.

2.7.4. Farmers' attitudes to sustainable agriculture

Apart from measuring sustainable development performance, it is also important to explore the attitudes of the participants in fresh vegetables supply chain towards the various elements of sustainable development regarding their business. Considerable effort has been made to explain farmers' conservation behaviour or the (non)-participation on various agri-environmental schemes, which could provide useful insights, in terms of methodological issues, to find out the factors that influence the sustainability of fresh vegetables supply chain.

Carr and Tait (1991) used the Theory of Reasoned Action (TRA) to explain differences in the attitudes of Bedfordshire farmers and conservationists and their implications on hedge removal. Moreover, Beedell and Rehman (1996; 1999; 2000) used the Theory of Planned Behaviour (TPB), extension of TRA to explain also Bedfordshire farmers' conservation related behaviour. The Theory of Planned

Behaviour is a replicable robust methodology (Beedell and Renham, 2000) and helps considering in a systematic way a broad range of factors that influence people's behaviour. However, the reliability of the results from this methodology is limited, among other reasons, by the fact that respondents are asked to self-assess their behaviour and that the behavioural measurements are snap-shots of the behaviour in time (Beedell and Renham, 2000). Moreover, TPB requires a single quantitative measure of behaviour. However, the author of this thesis believes that there is no single behavioural measure of sustainable performance. Thus, it seems that TPB could not be applied in this study; however, it could be used to consider in systematic way the factors influencing the sustainable behaviour of the participants in the fresh vegetables supply chain.

Morris et al. (2000) used the theory of diffusion and adoption of innovation to understand farmer attitude towards and willingness to participate in the Countryside Stewardship Arable Options Scheme. They found, inter alia, that for this agri-environmental scheme to be attractive needs to be perceived by farmers that it is practical and offers adequate environmental and financial reward. However, the author of this thesis feels that the theory of diffusion and adoption is not suitable for his study because it does not aim to explain, for example, farmers' participation to a sustainable activity, but to explore the attitudes of the participants in fresh vegetables supply chain towards the sustainability of their business.

Morris and Potter (1995) studied the level of farmers' engagement that enrolled in Environmental Sensitive Areas (ESA) schemes in South East England and they developed a 'participation spectrum'. Wilson G. (1996) used also TRA as conceptual framework to explore farmer attitudes towards the Cambrian Mountains ESA scheme participation and he suggested an expansion of Morris and Potter's (1995) concept of a 'participation spectrum'. The notion of participation spectrum could probably be interesting to distinguish the participants of the supply chain according to their perceptions on the various elements of sustainability of their business and could probable be applied in this study.

The factors influencing the sustainability of fresh vegetables supply chain over time have not been studied yet. However, the literature review on the factors influencing

the adoption of agri-environmental schemes was rather useful as it gave methodological insights for this research.

2.8. Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB), an extension of Ajzen and Fishbein's Theory of Reasoned Action (TRA), helps understanding the relationships between a single behavioural measure and its underlying determinants (Ajen, 1985; 1988; 1991; Ajen and Fishbein, 1980; Ajen and Driver, 1992). Although, the author of this thesis thinks that there is no single sustainability measure of fresh vegetable supply chain, it was found that it would be useful to review the main points of this approach because this study deals with the relative importance of factors that influence on actor's behaviour and actions, and supply chain's performance in terms of sustainability criteria.

Ajzen and Fishbein (1980) argued that their Theory of Reasoned Action provides a complete explanation of volitional control. TRA is more appropriate when the initial stages of the research indicate that volitional choice is not significantly impeded (Thompson et al, 1994). TRA assumes that the behaviour is outcome of attitudes towards a behaviour, reflecting personal beliefs and interests and subjective norms, reflecting felt social influences. In fact, TRA does not merely look for a person's attitudes and subjective norms but it also deals with reasons that people hold the attitudes and norms they do (East, 1990; Beedell and Rehman, 1999).

A criticism of TRA is that factors like age, sex, social class and race are not explicitly included, but one could argue that that such factors are included, implicitly, through attitudes and social influences (Beedell and Rehman, 1999). Moreover, the TRA cannot be successfully been applied when the volitional choice is significantly impeded. However, Azjen (1985) proposed the addition of perceived behavioural control as the third component of TRA (forming TPB) can be the answer when the volitional choice is impeded. Perceived behaviour control is the product of a person's assessment of the probability of the belief affecting behaviour, weighted by a person's

subjective evaluation of the power of the control belief to affect performance of the behaviour.

TRA and TPB have already been used in a wide range of research carried out to understand and predict human behaviour (Granberg and Holnberg, 1990; Raczynski et al 1998). Thompson et al (1994) also studied consumers' attitudes on the consumption of olive oil in the UK using TRA, while Berg et al (2000) and Gumesson et al (1997) applied TPB to predict intentions and behaviour of Swedish children at breakfast. Moreover, there are applications of TPB for understanding and predicting environmental behavioural intention and actual behaviour of selecting traffic modes (Priewasser, 1999; Kaiser et al, 1999), of buying environmental friendly products (Kalafatis et al, 1999) and of voluntary use of waste recycling receptacles (Chan, 1998). TRA and TPB have also been applied or used as conceptual framework in several studies to understand farmers' conservation behaviour (Beedell and Rehman, 1996; 1999; 2000; Carr and Tait, 1990; Lynne et al, 1995; Wilson, G., 1996).

2.9. Conjoint Analysis

Conjoint analysis is based on the hypothesis that people establish preferences for a product or a concept considering some relevant attributes that define it (Dillon et al, 1994; Green et al, 1988). A very important limitation of conjoint analysis is that these factors should not be more than 5 or 6, because it would be difficult for the respondents to consider all of them together (Green et al, 1988). The author of this thesis finds that conjoint analysis could be applied in this study to explore the relative importance of economic, environmental and social performance on the decision making of the participants in the supply chain with respect to their fresh potato business.

There is growing number of Conjoint Analysis applications in the agriculture and food related sectors, where the relative importance of products or services attributes is measured (Baidu-Forson et al, 1997; Baker, 1998; Benedict et al, 1987; de Souza Monteiro et al, 2001; Gil et al, 1997; Murphy et al 2000; Ness et al, 1994; Reid et al, 2001; van der Pol et al, 1996; Skytte et al, 1998; Loader et al, 1999).). Conjoint

Analysis has also recently been used to analyse the choice of British abattoirs and retailers between beef procurement channels (Hobbs, 1996a; 1996b; 1996c), the lamb-buying preferences of Canadian abattoirs and producer marketing groups (Stanford et al, 1999) and the importance of quality assurance for beef mince for UK consumers (Walley et al, 1999). Conjoint analysis has also been used to measure the preferences in supply chain design (Reutterer et al, 2000) and to assess business-to-business relationship quality (Naude et al, 2000) and supply chain relationships in agrifood sector (Boger et al, 2001).

2.10. Changes in Fresh Potato Supply Chain in Terms of Sustainability over the Last 10 Years

2.10.1. Introduction

Some of the changes that took place in the fresh vegetable supply chain during the last decade have already been mentioned in previous paragraphs. This part of the literature review presents evidence on the impacts of factors such as government policy, consumer demands and farm assurance schemes on the sustainability of fresh vegetables supply chain, in general, over the last 10 years. These findings can help to better explain the changes at single stages of the supply chain, namely, farming, distribution and retailing and the evidence on their sustainability assessment.

2.10.2. Government policy

There is a great number of UK Acts and Statutory Instruments, which are relevant to the production, distribution, and retailing of fresh food in general. The relevant law can be classified to financial, environmental, food, health and safety, and trade and industry (EC 1996a; 1996b; 1996c; 1996d; Croner 1997; 1998a; 1998c; MAFF, 1998b). Moreover, there are several EU or UK agri-environmental schemes in place in order to reduce negative environmental impacts of agriculture (Morris and Potter, 1995). The Potato Marketing Scheme also, which was supporting the UK potato

sector, came to and end in 1997 (Rickard, 2000). Thus, it is very probable that governmental policies have considerable impacts on the structure and the sustainability of fresh potato supply chain, which are worth to be explored.

Wilson (1996b) mentions that the UK Food Safety Act of 1990, with its 'due diligence' clause that retailer got all the precautionary measures to provide consumers with safe food, is one of the most important factors for the restructure and redesign of fresh food supply chain during the last decade. Howe (1998) observed also that the UK legislation does not set any ongoing restraint upon the creation and exercise of market power by large-scale distributors. This has resulted in the increased market concentration in the UK retailing. Hence, the market share of independent (small) groceries significantly declined and the market power of major retailers increased a lot.

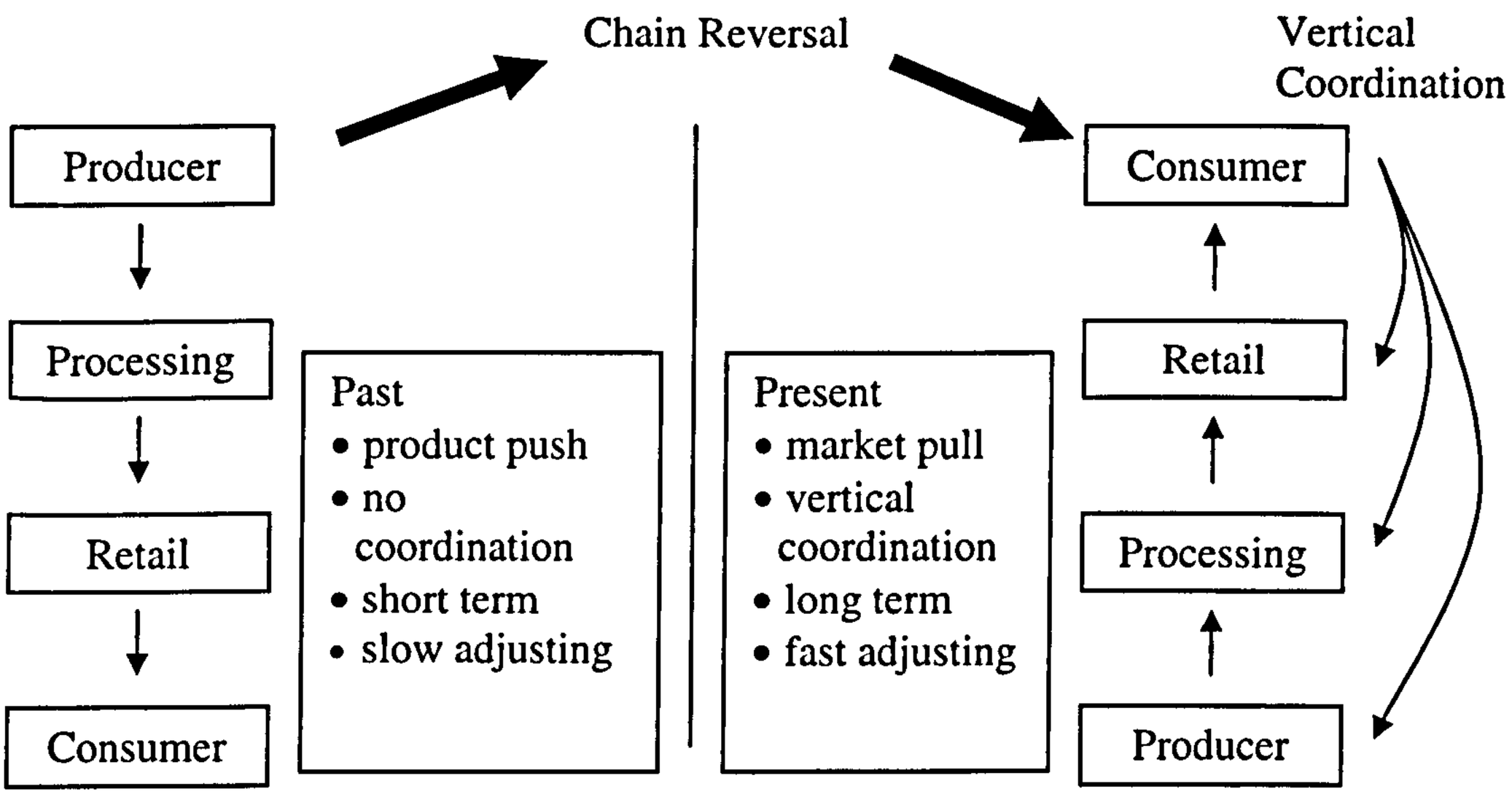
The UK government previously had supported the potato sector mainly by the Potato Marketing Board, whose main element was setting area quotas to producers, in order to avoid the over-supply of potatoes in the market and thus farmers would potentially achieve relatively satisfactory prices. In 1980s the government, encouraged by the European Community (now European Union), favoured more deregulated markets and thus the level of support provided through the PMB started to decline. In 1985 the deficiency payments scheme was abolished and since 1997 the area quotas ceased to exist (Rickard, 2000). In 1997 the PMB gave its place to the British Potato Council, which is funded mainly by its levy-payers and its main objectives are, as a body working for the whole industry, to increase potato consumption, reduce unit costs of production and help farmers to produce potatoes that meet the increasingly high consumer assurance and food safety requirements (Millar, 1998). Thus, the potato sub-sector is no longer directly supported by government intervention.

2.10.3. Demand for fresh potatoes

The most important change of the European food supply chain in the last 10 or so years has been the redesign and repositioning of a production-driven supply chain to a market-driven supply chain (Folkerts et al, 1998) (Figure 2.3). The success of the food

supply chain lies on satisfying, as far as possible, consumers' needs (Anonymous, 1999; Key Note, 1999a). Consequently, the changes in consumers' needs for fresh potatoes during the last 10 years have played a very important role in the structure formation and performance of the supply chain.

Figure 2.3. Chain reversal in agribusiness and food supply chains



Source: Folkerts and Koehorst (1998).

Significant societal changes have taken place in the UK during the last decade or so. There is a slow growth in population in Northern Europe and this is also the case in the UK. This results in higher age profile of the population and consequently there is change in consumption patterns (lighter and healthier diet is preferred). More women work outside home nowadays than before, as services are becoming more important in the economy of the country. The household numbers are increasing and the average household size is decreasing. The households are, also, better off financially than they were in the past, although the gap between the 'have' and 'have nots' is increasing (Mintel, 1998; Hughes D. et al, 2000; Millar, 1998). Consumers feel also more nowadays that food reflects the sort of person we want to be and be perceived to be.

Consumers are now more aware of their body shape. Being thin usually indicates a better off financially person, whereas several years ago it was the contrary (Hughes D. et al, 2000).

These changes in the society have significant impacts on consumption habits of food products including potatoes. Thus, today's consumers increasingly prefer pre-packs to loose potatoes and processed potatoes to fresh. This is because consumers increasingly look for convenience when making their choices at retailer shelves. Working consumers in Great Britain spend less than 30 minutes a day cooking (MacCarthy, 1999). Thus, although fresh potatoes still account for about 60% of overall potato consumption, the balance is shifting to processed potatoes and it is predicted that by 2005 processed potatoes consumption will overtake fresh consumption (Anonymous 2000a; Rickard, 2000).

Apart from population and demographic changes, important social changes are also taking place. The average education level is rising resulting in more informed and aware consumers about food industry issues. Consumers are considered to read food product labels more carefully and to be more concerned about issues like ethical trading, environmental pollution, organic food and GMOs (Genetically Modified Organisations) than in the past (Hutchins, et al, 1997; Jones et al 2000; Stainer et al 1998). Thus, it is perceived that the food supply chain needs to reassure consumers that their increasing environmental and social concerns are taken in consideration, without, if possible, increasing substantially the price of food products.

Consumers' changes in eating habits are playing very important role on the changes of fresh potatoes supply chain structure and its performance. Consumers' desire to minimise cooking and shopping time coupled with their increasing awareness for food safety, quality, environmental and ethical issues are among the most important reasons for multiple retailers boost in the last decade or so (Hughes D. et al 2000). Moreover, multiples have exploited economies of scales to make the food supply chain more effective and efficient, as consumers although more prosperous than in the past, remain sensitive to the product prices. In 1998 multiple retailers and supermarkets accounted for 80% of retail potato sales (value share); up from 53% in 1993 (Bicknell, 2000). This is because multiple retailers exploiting the new technologies, such as the

advances of Information Technology (logistics, product Bar Code System) managed to better organise their business and improve the selection of information about consumers' demands than the traditional greengrocers (Hughes D. et al 2000).

Multiple retailers' boost and the great negotiating power they acquired, to the disadvantage of the participants of other stages in the supply chain, have resulted in significant changes in the marketing channels and the relationships between the players of the food supply chain. Traditional wholesale markets, such as Nine Elms, lost most of their power and they play little role influencing the farm gate prices. New concepts like Supply Chain Management (SCM), Efficient Consumer Response (ECR) and Category Management (CM), which require very close relationships between the participants of the supply chain, have been adopted by multiples and are imposed to the food supply chain in order to face the challenges to deal more efficiently and effectively with consumer demands (Hawkesworth, 1998; Rademakers, 1999; Grant, 1995; Binet et al, 1997; Wilson, 1996b; White, 2000).

2.10.4. Farm Assurance Schemes (F.A.S.)

Farm assurance schemes are perhaps one of the most important changes in the food supply chain in the last decade with significant implications for its sustainability. Farm assurance schemes are crop protocols that set specific standards related to almost every activity, inputs and outputs of crop production. Farmers are obliged to keep records and report on the inputs and practices used in production, such as pesticide and fertiliser application, water use and management and obtain certificates that verify employee capability and knowledge to use agricultural equipments safely.

Farmers are obliged to implement a farm assurance scheme to prove that they apply Integrated Crop Management (ICM) or Integrated Pesticide Management (IPM). MAFF (1999) reports that only a small proportion of farmers use ICM production schemes. However, some big retailers (M&S, 1999; Sainsbury, 2001; Tesco, 2001e) are committed to source food products produced under farm assurance schemes. Thus, farm and food assurance is almost a norm nowadays, especially for those farmers supplying

food products to multiple retailers, and it is generally argued that in short time no food products will be traded without being certified (Jack, 1997; Hughes, D. and Merton, 1996; Lunniss, 1997b).

Farm and food assurance became important after the enactment of the Food Safety Act of 1990, which introduced the concept of 'due diligence'. This means that every actor of the supply chain must be able to prove that he takes all reasonable precautions and exercises all due diligence to avoid any charge to himself or to a person under his control. The BSE crisis and the outbreak of *E. Coli* poisoning in Scotland (both in 1996) coupled with the ghosts of past food safety scares that have occurred since the mid 1980's (*Salmonella* in eggs, *Listeria monocytogenes* in soft cheese and pate) resulted to an increased interest for farm assurance (Grimsdell, 1996).

Supermarkets have played a key role in the expansion of farm assurance because of the consumer demand, as they claim. Early (1998) doubts that this is the real reason that made the supermarkets get so fiercely involved in this issue. Instead, he supports that behind their claims about consumers' demand and the concept of 'due diligence' is their desire to standardise food, increase their control over the supply chain and increase their profit margin. However, key retailers, distributors, processors and farmers' unions claim that farm assurance is essential to supply safe food to consumers which has been produced by using natural resources in a prudent way and minimising the risk of environmental pollution (Tinsley, 1997; Lunniss, 1997a; 1997b; Chapple, 1997; Hilborn, 1997; Jack, 1997).

Farmers have to pay, either directly or indirectly, to be members of farm assurance schemes. However, farmers naturally expect a return on their investment, which is to secure a preferred market with possible price premium. Caswell and Henson (1998) mention that in the meat sector these schemes are becoming *de facto* standards for suppliers trading with large meat processing companies and multiple retailers. Consequently, farmers that do not comply will be excluded from these markets.

Moreover, it is commonly agreed that the standards of farm assurance schemes will raise in the future, as well as the burden of administration and bureaucracy. This raises concerns whether such assurance schemes will favour bigger farms who can carry

the burden of cost relative to small farms (Early, 1998). MacDonald et al (1996) found that the implementation of US Food Safety Regulation, which refers to the application of HACCP method by meat processors, would be as 100 times more costly (as a proportion of their sales value) to Small and Medium Enterprises (SMEs) than to large companies.

Buyers of farm produce, food manufacturers and multiple retailers seem to have clear benefits from farm assurance. Farm assurance brings a greater control over the food supply chain to them, especially to those that are already powerful. Farmers who already deal with multiple retailers and big distributors often complain that they have to sell their produce at low prices. Such complaints may increase with the importance and necessity of farm assurance schemes. Moreover, to the extent that supermarkets are in total control of the quality and safety of food, for and behalf of consumers, they may prove more diligent and influential in raising food standards than the new Food Standards Agency (Early, 1998). However, private standards such as those of farm assurance schemes, in contrast to public such as those defined by food legislation, tend to lack transparency, because, although they need to be verified by third party, they do not need to be justified, as the public have to do (Henson, 1997). Thus, it is relevant to study how the relationships between the participants of the different stages of the supply chain have changed over the last decade and what are the implications of these changes on the sustainability of fresh potato supply chain.

Serious steps have recently been taken to the standardisation of farm assurance schemes and the processes by which are verified. The British Farm Assurance scheme has been in operation for one year, while multiple retailers across Europe, including the major British, join their forces to create single pan-European farm assurance schemes (EUREP, 2000). For the farm assurance to be sustainable it should offer meaningful benefits to farmers as much as to the others players in the food chain and ensure the survival of all farms, not just the largest and cash rich (Early, 1998).

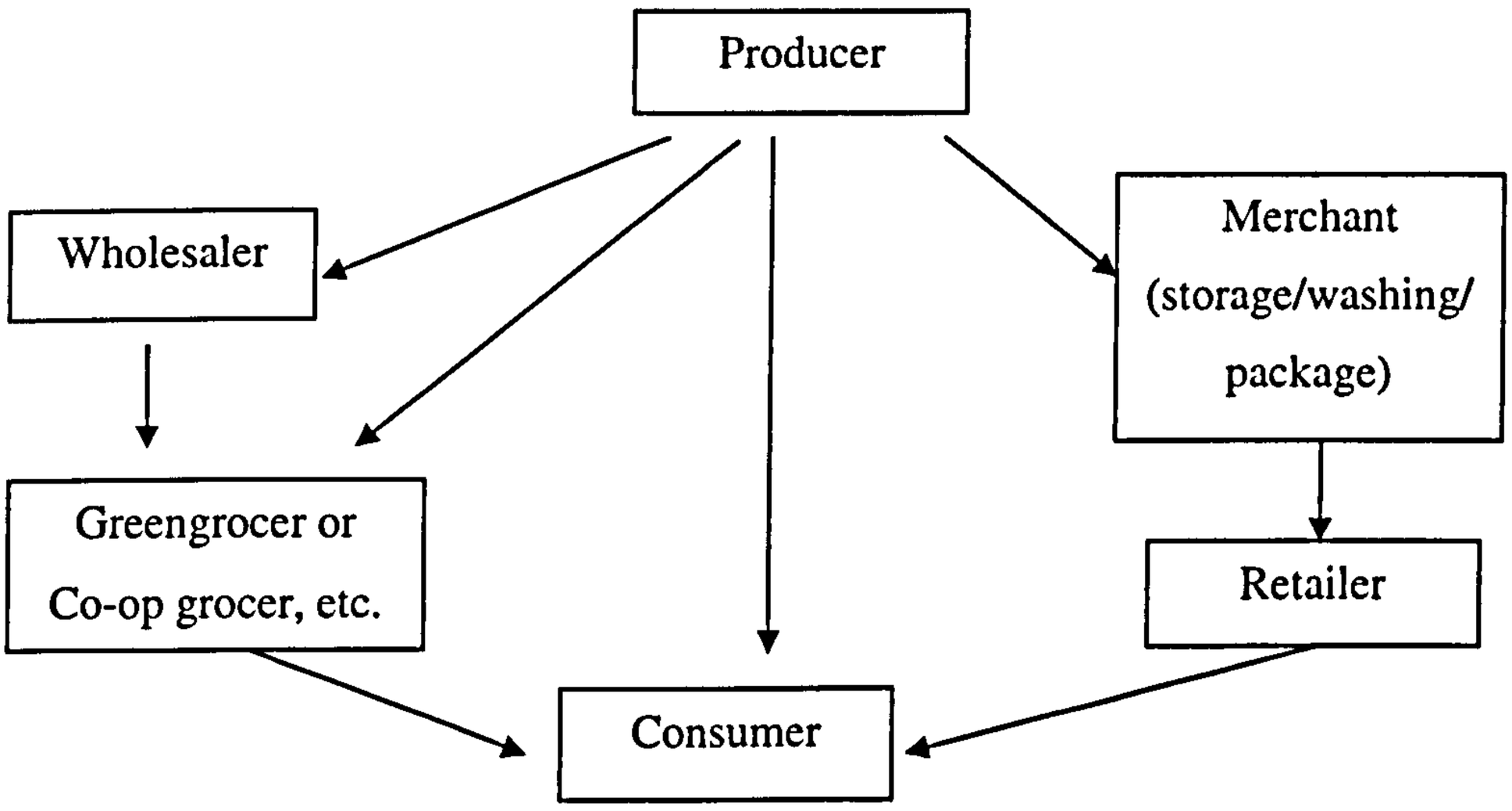
2.11. Sustainability Assessment of the UK Fresh Potato Supply Chain During the Last 10 Years

The next paragraphs deal with the findings from the literature on the performance of the UK fresh potato supply chain during the last decade. The distribution channels of fresh potatoes in the UK are, initially, presented, followed by the changes at retailing, distribution and farming level in terms of sustainable development. These findings can help, among others, to identify key areas of interest in terms of assessing the sustainability of fresh potato supply chain, which are not sufficiently covered by the literature and thus provide a form for further enquiry.

2.11.1. Distribution channels of fresh potatoes in the UK

There are several marketing channels by which UK fresh potatoes arrive in consumers' hands (Figure 2.4), the most dominant of which is farmer→ merchant/packer → major retailer (Custance et al, 1999; Bates et al., 1996).

Figure 2.4. Major distribution channels of fresh potatoes in the UK



Source: Custance et al, 1999; Bates et al., 1996

The importance of the various distribution channels has changed significantly during the last decade or so for the favour of multiple retailers (Anonymous, 1998c). Traditional wholesale markets have lost most of their importance. Direct farmer sales either to consumers or to independent grocers have been little affected by the changes in the supply chain, but the market share, of both, in value does not exceed 10% (Millar, 1998). Moreover, it is worth mentioning that sometimes when the fresh potatoes do not meet multiple retailer criteria these are sold in the wholesale market.

2.11.2. Retailers

Large retailers (including supermarkets and superstores) have steadily increased their market share, both in value and volume of the grocery market in general (Tables 2.1 and 2.2). The top five grocers accounted for over 50% of the UK grocery market in 1998 (Key Note, 1999b).

Table 2.1. Annual UK grocery sales by size of business at constant 1995 prices (£m)

	Small	Large	Total
1990	21989	50168	72157
1995	17201	57713	74914
1996	16608	59869	76477
1997	17018	62683	79701
1998	16723	64813	81536
1999e	15728	66580	82308
e- estimate			
Large grocery store is defined as a self-service grocery store of more than 2,000 square feet in size.			

Source: MAFF; Key Note, 1999b.

The relationships between the participants of the food supply chain have changed significantly during the last decade. The concept of integrated supply chain management prevails and has replaced confrontation between actors. The co-ordination between the participants the UK fresh potato supply chain is high, as multiples tend to

establish long term relationships with few suppliers and these suppliers tend to be supplied by relatively few farmers (Binet et al, 1997; Wilson, 1996b; Hughes, D. et al., 1996; Fearne, et al., 1999). However, there are also continued complaints by producers that multiple retailers use their power to squeeze farmers' profits, and this tactic seems to lead to problematic relationships in the supply chain. This probably happens because there is fierce competition among multiple retailers for high quality food products at low prices, which is reflected to the rest of the supply chain because of the relatively high negotiating power of major retailers over their partners in the supply chain (Harvey, 2000; Hogarth-Scott, 1999).

Table 2.2. Proportion of potatoes expenditure and weight sold in retailer outlets in 1998*.

	% Expenditure Share	% Weight Share
Multiples	77.9	69.4
Co-op Grocers	3.6	3.4
Independents/ Symbols	2.0	2.8
Milkman	0.4	0.8
Greengrocer/ Fruiterer	8.2	11.8
Covered Open Air Market	2.9	4.1
Farm shop/ Stall	1.7	4.3
Other Outlets	1.8	0.7
All Other Outlets	1.4	2.6
* Year ending 18.10.98		

Source: TN SOFRES (adopted from MacCarthy, 1999)

Literature review revealed that a systematic research has not so far been carried out to measure the performance of potato business at retail stage in terms of economic, environmental and social criteria. However, useful information on the overall business financial performance can be derived from the financial reports that major retailers publish usually every year. Moreover, the operating margins of multiple retailers are more than the double their Continental or North American counterparts, reaching on average at 5 to 6% (Key Note, 1999b; Hughes and Ray, 2000). Taking into account

their increasing market share through the last decade, we can conclude that their financial performance was relatively good (Hughes, 2000). However, while there is little information about the financial performance of small or independent grocers, the fall in market share from almost 90% in 1980 to less than 20% in 2000 suggests declining relative productivity and financial performance (Millar, 1998).

There is also significant documentation about the environmental and social performance of some retailers. Sainsbury, for example, have published Environment Reports every year since 1996 (Sainsbury 1996; 1997; 1998a; 1998b; 1999; 2000; 2001). Other major retailers like Tesco (2001a; 2001b, 2001c; 2001d; 2001e), ASDA (1998) and Marks & Spencer (2001) also report their targets to improve their performance in terms of environmental and social criteria over the next few years and what has already been achieved.

According to these reports some major retailers have significantly increased their supply base of farmers adopting farm assurance schemes and some of them claim that great part of the vegetables of UK origin are produced under farm assurance schemes (Tesco, 2001e). Farm assurance schemes are perceived by a great number of people and businesses involved in the fresh food supply chain to improve the sustainability of food supply chain in general, and retailers were also among the pioneers of farm assurance schemes such as Tesco's Nature's Choice, Sainsbury's Farm Assurance Scheme and M&S's Select Farms (Focus on Farming Practice, 1999; Tesco, 1998; M&S, 1999; ADAS, 1999).

Major retailer also report their target in reducing emissions to air from ozone depleting substances by removing CFC refrigerants from refrigeration systems (Sainsbury, 1998; Tesco, 2001a). Moreover, they aim to reduce the distance that food travels from farm to its last destination by better co-ordinating their transportation system with their suppliers, as well as significantly reducing emissions to air resulted from food transportation (Sainsbury, 1998; Tesco, 2001d). New technologies are also adopted to reduce energy consumption per square metre of sale area (Sainsbury, 2001; Tesco, 2001b). Major retailers' waste recycling programme is also becoming more intense as the volume of recycled plastic shrink-wrap and cardboard is increasing every year (Tesco, 2001c).

Major retailers also consider the social aspects of their business. Personnel training is increasingly important for multiple retailers in order to retain their market share and be competitive. Moreover, multiple retailers have created several new jobs and the biggest of retailers employ 70 to 200 thousands people each (KeyNote, 1999b). Multiple retailers have made a commitment to prefer the local supply base to imports (Anonymous, 1998e). They are also supporting British farmers to increase their organic produce in both variety and volume (Sainsbury 1999; MacCarthy, 1999).

The information derived from financial or environmental and social reports of major retailers provide significant insights into the changes of their whole business performance in terms of sustainable development. However, it is difficult to determine from these reports some measure of sustainability per unit of activity of turnover such as a tonne of fresh potatoes, which is the aim of this study.

2.11.3. Merchant-packer

There is little evidence related to the performance of merchant-packers potato businesses in terms of economic, environmental and social criteria. The number of merchants has declined dramatically during the last 10-15 years as well as the importance of wholesale markets. The interviews carried out for this research and discussions with British Potato Council also revealed that the actual number of fresh potato suppliers of each major retailer varies between 3 to 10.

It should also be mentioned that the services that merchant-packers offer to multiple retailers differ significantly to what wholesalers offer to greengrocers. Merchants make specific investments to satisfy individual multiple retailer demands. Each merchant provides fresh potatoes to major retailers in a great variety of forms, packages, and quality standards. Moreover, all potatoes arriving at the packhouse of big merchants pass first through quality control before being stored. Multiple retailers are also looking for ever-increasing service levels, but the cost for these additional services is often to great extent covered by packers, squeezing their profit margins (Anonymous, 1998a).

Unfortunately, there is limited published documentation about the environmental performance of fresh potato packers. However, merchants often carry out environmental audits, as this is often asked also by multiple retailers (Sainsbury 1999). Hence it is probable that merchants' business performance in terms of some environmental aspects improves over time.

Storage is crucial for potatoes in order to keep them in good condition and to minimise wastes. Storage is a factor that increases costs but also adds value to potatoes since they can be disposed later at better prices. However, storage can also contribute to environmental pollution. There have been significant recent improvements in storage technology as a result of environmental organisations and businesses involved in the food supply chain (Demicheli, 1996).

Another area of environmental concern is packaging material. However, supermarkets and consumers are mainly responsible for dealing with packaging material after product's display and use respectively. Water consumption and its disposal after use is an area of environmental interest as fresh potatoes are always washed. Environmental laws cover the disposal of dirty water in rivers and consequently adequate measures have to be in place to avoid environmental pollution (Croner, 1998a).

Packers of fresh potatoes invest also continuously on developing and improving their personnel skills, in order their business to be competitive and ready to face new market challenges.

2.11.4. Production of potatoes in UK

One of the most important changes in the potato sector was the abolition of the Potato Marketing Board, which gave place to British Potato Council in 1997. Among the most significant changes the new regime brought were the abolition of intervention and of production quotas (Rickard, 2000). This change coupled with the high level of co-ordination between the participants of the fresh potato supply chain had significant implications for the production and marketing of potatoes.

First of all, the number of registered producers has steadily decreased. The total area of plantings is also decreasing but at a lower rate than the number of producers (MacCarthy, 1999; PMB, 1997) (Table 2.3). This has resulted in farmers holding bigger potato enterprises nowadays than in the past and a minority of farmers produce the great majority of fresh potatoes. In 1995, for example, producers who held potato enterprises bigger than 20 hectares accounted for 11.9% of the total number of potato farmers but they produced 65% of the total produce (PMB, 1996). Potato farmers may also establish co-operatives in order to market their crop under better conditions and in some other cases, the co-operatives merge with major potato merchants. For example, Anglian Produce, a co-operative which handles around 444,000 tonnes of potatoes, merged with Greenvale, the biggest packer in Britain (Anonymous, 1998a).

Table 2.3. Area of production and registered producers for fresh potatoes

	1960	1970	1980	1985	1990	1994	1997	1998
Area of production '000 ha	322	259	192	165	153	152	146	144
Registered producers	76825	43346	30225	24948	18331	14900	9772	7530

Source: PMB and BPC

Table 2.4 shows that although, yields tend to be slightly increasing after 1985 reaching, on average, at 44 tonnes/hectare nowadays, there is significant fluctuation from year to year[1], which influences significantly the level or prices that farmers can get for their crop. Moreover, Rickard (2000) mentions that, despite the Potato Marketing Scheme (area quota scheme until 1993), there was a positive relationship between the average potato price and the area sown in the following year. However, this relationship has become more unstable over recent years.

Murphy's (1997; 1998) reports on farming in the Eastern counties of England and Rickard (2000) show the great variability of gross margins of potato production

[1] Weather usually influences significantly the volume of yield.

during 1976-1996, which is largely explained by the variability in prices (Table 2.4). Moreover, Murphy's (1997; 1998) reports show that there is a big gap in the gross margins between the mean of the highest and the lowest quarter performing farms. This is attributed mainly to the prices that the best performing farms achieve, because of the higher quality of potatoes produced. Taking into account that profit margins, especially in recent years, have been squeezed, this difference in the price can make the difference between profit and loss. Thus, variability of prices and yields are critical determinants of the performance of farm enterprises.

Table 2.4. Fresh potato statistics on yield, total production, price, returns, variable costs and gross margin for selected years

	1988/89	1989/90	1993/94	1994/95	1997/98	1998/99
Yield (tonnes/ha)	39.16	38.63	48.02	39.97	48.0	44.4
Total production ('000 tonnes)	6590	5973	6808	6263	6853	6171
Price (£/tonne)*	62.55	99.09	79.52	156.86	76.29	147.16
Returns*	2697	4438	4145	7433	2988	6536
Variable Costs*	1382	1486	1495	1727	1895	1925
Gross Margins*	1315	2952	2650	5706	1093	4611
* Current prices						

Sources: MAFF (2000); Rickard (2000); Murphy (1998).

Wilson et al (1998) developed a technical efficiency index of UK potato production based on a number of managerial and farm characteristic variables such as land, fertilisers, labour and machinery. They found that the technical efficiency index across production units of UK potato production ranges from 33 to 97 percent. Producers with fewer years of experience, with relatively large farms, with irrigation, with storage facilities and not chitting seed potatoes are expected to have higher levels of efficiency. Moreover, they mentioned, rather interestingly, that the majority of potato producers operate close to maximum technically feasible production levels and that there is limited potential to improve technical efficiency. Thus, issues like size of potato

enterprise, storage capacity and irrigation would also be considered when measuring the performance of potato enterprise.

Although there is much information about the financial and economic aspects of potato production in the UK there is very little information about the environmental and social impacts of the potato production in the UK. However, environmental issues related to agriculture, in general, like soil erosion, fertiliser and pesticide application, water and energy consumption, and waste production have attracted the attention of governmental and non-governmental bodies as well as the actors in the potato supply chain itself (MAFF, 1999; 1998a; Skinner et al, 1997; Sainsbury's, 1998; Pretty et al 2000). Moreover, in recent years attention has returned to issues such as agricultural employment, farmers' skills, and average earnings of agricultural workers especially in the context of concern over rural future (MAFF, 1999). Thus, it is relevant to study the environmental and social impacts of the UK potato production alone.

2.12. Rationale of the Study

Sustainable development is an issue of increasing importance at both national and international level. Moreover, significant changes have taken place in the UK fresh vegetables supply chain in the last decade which have resulted in much closer co-ordination of the participants in the supply chain in order to satisfy the increasingly sophisticated demands of the consumer. In fact, it is argued that companies are no longer separate units in a competitive battle, but it is now whole supply chains which compete each other. Special attention has also been drawn to the environmental and social impacts of the UK fresh vegetable supply chain during the last decade by the government and the participants of the supply chain. In fact, major retailers, driven by the fierce competition at the retail stage where the power base for the supply chain appears to lie, have taken several initiatives aiming to improve aspects of the sustainability of the whole fresh produce supply chain. Fresh potatoes are also, probably, the most important fresh vegetables in British diet and food industry.

The literature review revealed that the sustainability of food supply chains, in terms of economic, environmental and social performance, and factors that influence it have not so far received much attention by researchers. However, sustainable development is a key issue for the agriculture sector and food supply chain in general. The UK government, and the major retailers, especially, coupled with their partners in the supply chain have committed themselves to improving the sustainability (economic, environmental and social aspects) of the food supply chain. Consequently, the assessment of sustainability of fresh potato supply chain and the participants' perceptions on the factors influencing the sustainability of their business, the broad aim of this study, is a valid and relevant topic of research.

The literature review revealed also that models or methodologies have not been developed to assess the sustainability of supply chains as a whole. However, it was found that some of the methods and models reviewed could be combined together to develop an approach to measure the performance of fresh potato supply chain in terms of sustainability indicators and also explore the factors that influence the sustainability of the supply chain. Thus, the first research objective of this study is considered potentially attainable. Once this is achieved, it is considered feasible to study the change in the performance of fresh potato supply chain during the last decade (research objective 2), to explore the factors that have influenced these changes (research objective 3) and also to identify the actions can be taken to improve the sustainability of the fresh potato supply chain (research objective 4).

The approach developed for the purposes of this study could be used as a basis for certification on behalf of the main players of the fresh potato supply chain that their activities demonstrate a degree of sustainability. It can also be used by public agencies in order to assess the degree of sustainability of the various production, distribution and retailing systems and find out how they should better intervene into the market. The developed approach could also help to better understand the links between the selected factors and the performance of the supply chain in terms of sustainability criteria. These findings would be important in making the appropriate proposals for improving the performance of the supply chain. The developed approach could also be used elsewhere to assess the sustainability in different supply chains of fresh vegetables, although it is

likely that some amendments should be made to consider the particular characteristics of each fresh vegetable supply chain. For these reasons, the study topic is regarded as a valid topic for research.

2.13. Summary of Chapter

This chapter defined the study topic and dealt with its boundaries. It confirmed that the assessment of sustainability of the fresh potato supply chain, the aim of this study, is a valid and relevant topic of research. Although no model or methodology has been developed to assess the sustainability of supply chains, the literature review revealed several methods and models which could help to develop an approach to realize the aim and objectives of this study. This approach is presented in the next chapter.

CHAPTER 3

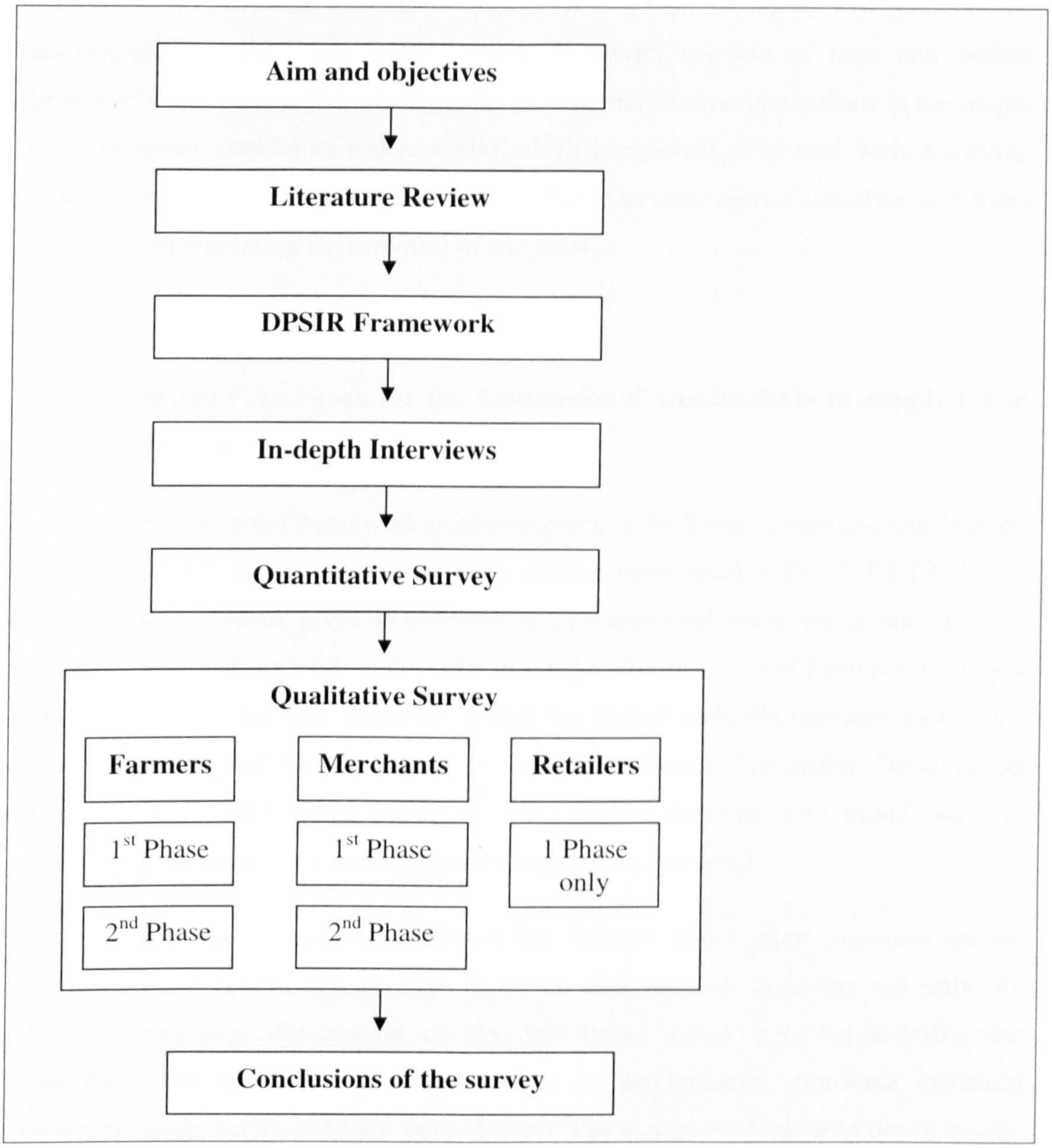
MODELS AND METHODS

This chapter deals with the approaches used to address the aim and objectives of the research. It also describes the data selection methods and data analysis approaches used to answer the research questions-objectives. A summary is included at the end of this chapter.

3.1. Overview of Methodology

As shown in the study route map (Figure 3.1) this research is based on the conceptual framework of Driver-Pressure-State-Impact-Response (DPSIR) (see § 2.5.2). The in-depth interviews with representatives of the fresh potato supply chain explored issues related to the sustainability of the supply chain during the last 10 years, building on issues identified in the existing literature. The findings from the in-depth interviews coupled with the literature review were used to study the fresh potato supply chain in terms of economic, environmental and social issues, and also to design the quantitative and qualitative survey. The quantitative survey aimed to assess the performance of fresh potato supply chain over time according to selected economic, environmental and social (sustainability) indicators in an objective manner. A questionnaire (qualitative survey) was also sent to farmers, merchants and retailers to explore the reasons behind the changes in the performance of fresh potato supply chain in terms of economic, environmental and social criteria. The qualitative survey aimed also to assess the performance of fresh potato supply chain according to selected sustainability indicators in a qualitative way. Conjoint analysis was also used to explore the relative importance of economic, environmental and social performance in farmers, merchants and retailers' choice for fresh potato supply chain systems.

Figure 3.1. Study route map



Consumers are an integrated part of the food supply chains. The ultimate aim of the participants in the food supply chains is to satisfy consumers' requirements, and thereby meet their own needs. The Government and public agencies are also interested in the sustainability of food supply chains because their main role is to protect the public interests and improve society's welfare. Thus, the perceptions of consumers and public agencies about the changes in the performance of the food supply chains in terms

of sustainability criteria and the factors that have influenced on these changes are also valid topics for research, and necessary in order to obtain a complete assessment of the sustainability of the food supply chains. However, because of time and budget limitations, it was decided to focus on the perceptions of those participants in the supply chain (farmers, merchants and retailers) which are mainly concerned with delivering products to suit consumers requirements, rather than consumers themselves and those charged with regulating the activities of suppliers.

3.2. Conceptual Framework for the Assessment of Sustainability of Supply Chain for Fresh Potatoes

The conceptual framework of this research is the Driver-Pressure-State-Impact-Response DPSIR framework, which is described in more detail in §2.5.2 (DETR, 2000). The DPSIR framework gives an overview of environmental, social and economic links and provides the framework to consider the sustainability issues of fresh potato supply chain in a systematic way. However, within the overall umbrella provided by DPSIR, other methodological tools such as Life Cycle Assessment, Sustainable Development Records, Theory of Planned Behaviour and Conjoint Analysis were found useful to assess the sustainability of the fresh potato supply chain in detail.

This research focuses mainly on the Drivers, which exert pressures on the economy, environment and society. However, this research considers not only the driving forces (e.g. demand for quality, low priced food), but also identifies the underlying drivers for changes (e.g. changes in demographics, consumer increased awareness about health and food safety issues). The study also deals with the economic and financial Pressures that these drivers exert on the people and businesses engaged in the supply chain, and the Pressures exerted on the environment and the society. The changes of the State of supply chain over time in terms of economic, environmental and social criteria are also studied. Although, the Impacts are not dealt with the detail, the Responses from the participants in the supply chain and the government are explored.

The literature review and the in-depth interviews provided much information to apply the DPSIR framework on the performance of fresh potato supply chain according to economic, environmental and social criteria. The quantitative survey collected information about the pressures (e.g. production costs, energy consumption) on the supply chain and how its state changes over time in terms of economic, environmental and social aspects. Finally, the qualitative survey aimed to find out what are the main factors that influence the responses of the participants in the supply chain and to gather also information related to the changes of the state over time on issues that can not easily be quantified such as relationships with other partners in the supply chain.

3.3. In-Depth Semi-Structured Interviews

3.3.1 Interviews survey

In-depth semi-structured interviews were conducted with representatives of main participants of the supply chain for two reasons. On the one hand, they provided important information which, coupled with the literature review, was used to initially apply the DPSIR framework to describe the fresh potato supply chain in terms of economic, environmental and social issues in the last decade. On the other hand, they were found necessary in the design of the quantitative and qualitative survey.

The DPSIR framework was used as a conceptual basis to design the semi-structured questionnaires for in-depth interviews with selected actors of fresh potato supply including farmers, merchants, retailers and consumers. In-depth interviews were chosen instead of focus groups because it was thought that respondents would feel more comfortable to talk about some confidential issues. Moreover, it was necessary to visit respondents at their working places because most had limited available time for the interview. Questions for farmers, merchants and retailers aimed to explore (Appendix 1):

- Main characteristics of fresh potato business;
- Records kept about activities and applications of inputs;

- Main changes in fresh potato supply chain in the last 10-15 years;
- Factors influencing participant's decision making with respect to his/her potato business;
- Drivers for changes in the supply chain in terms of sustainability; and
- Other issues of particular concern at this moment or in the future.

Questions for consumers dealt with (Appendix 1):

- Frequency and outlet of buying potatoes;
- Factors influencing consumer decision making when buying potatoes;
- People or organisations informing consumers about issues related with production, distribution and retailing of fresh potatoes;
- Changes in their choices for potatoes buying in the last 10-15 years; and
- Other issues of particular concern at this moment or in the future.

Before the interview, the respondents received a brief written description of the aim and objectives of the survey, and a list of questions (topics) to discuss with them. Initially, respondents were asked if they agreed that the interview would be tape-recorded and all of them accepted. The interviewer made a brief introduction about the aim of the research and the expected outcomes of the interview. The respondents, in general, followed the order of the questions list, and the interviewer engaged in discussions of related topics when appropriate. The interviews lasted on average around an hour.

3.3.2. Sample of the study and data analysis of in-depth interviews

Three potato farmers, who participated in research projects of Cranfield University at Silsoe in the past, were selected for the interviews. Two of these farmers have large potato enterprises and sell their crop to merchants that supply major retailers with fresh potatoes. The third farmer, a relatively smaller potato producer compared to

the other two, has recently switched to producing for the processing industry because of uncertainty faced in fresh market and physical constraints of his farm.

The marketing managers of two potato packer companies were also interviewed. These companies are among the leaders in their industry and supply to major retailers. In addition, the fresh vegetables buying manager of a major retailing company participated in the interviews. Three consumers from the staff of Cranfield University at Silsoe were also selected for the interviews.

The interviews were first transcribed and read by the author. Interview findings were then grouped according to the topics mentioned in §3.3.1.

The author also explored further the sustainability issues related to the fresh potato supply chain when he visited again the same or other farmers, merchants and retailer representatives for the purposes of the quantitative and qualitative surveys.

3.4. Quantitative Survey

3.4.1. Analytical framework of quantitative survey

The literature review revealed that analytical tools have been developed to assess sustainability, and environmental and social impacts of selected levels of supply chain but not of the supply chain as a whole. Moreover, research has assessed the performance of supply chains in terms of financial aspects, but without dealing with environmental and social impacts. Governmental, international and research bodies have also proposed various assessment models of sustainability on national or local level and for the industry, but not for supply chains.

The quantitative survey was carried out to assess the performance of fresh potato supply chain over time according to the most important quantitative sustainability indicators. The quantitative survey was based on the findings of the in-depth interviews and on existing theories, concepts and methodologies. The Indicators of Sustainable Development (DETR, 2000) and the Life Cycle Assessment (Lewis et al, 1999) were the main methodological tools identified by the literature review to assess the

performance of supply chains in terms of sustainability criteria in an objective manner. Supply chain performance measurement methods and models (Beamon, 1998) also provided useful insights. However, they tend to focus only on some selected economic, financial and logistic issues, for the most part ignoring environmental and social aspects. Sustainable Development Records (Nilsson et al, 1998) are also used in this survey to interpret the data collected.

Some important criteria were also taken into consideration in the quantitative survey. First of all, the assessment should encompass all the three dimensions of sustainability, namely economic, environmental and social throughout the entire supply chain, from production to distribution and retailing of fresh potatoes. Moreover, it should not involve excessive demands for data. However, it should not miss important aspects of sustainability of the supply chain studied. It should be easily applied, not to be time and money consuming and finally it should lead to meaningful and unambiguous results, so that the conclusions and the set of actions to be taken to improve the sustainability to be clear. Moreover, the measures proposed should be credible from the viewpoint of various stakeholders (Croner, 1994).

The analytical framework derived consisted of a series of spreadsheets (i.e. MS Excel) for each stage of supply chain. These spreadsheets included horizontally all major activities or services that take place in the production, distribution, and retailing of fresh potatoes, and vertically the selected sustainable indicators. The indicators chosen for the quantitative study cover all three dimensions of sustainable development, namely economic, environmental and social. The unit of measurement of each indicator depends on the nature of each of them and the data presented is expressed per 1 tonne of fresh potatoes delivered to consumers (Tables A.5.1-A.5.18)

Initially, the draft assessment framework was presented to participants of the supply chain in order to be evaluated and refined. The assessment framework took its final shape after taking into consideration the difficulties faced in data collection and the different data classification systems used at different stages of the supply chain.

The analytical framework can potentially be used to certify that the activities of the main players in the supply chain are sustainable. It can also be used by public

agencies in order to assess the sustainability of the various production, distribution and retailing systems and find out how they should better intervene into the market. However, as described later, lack of data for the retail stages of the potato supply chain prevented its full application.

Three types of indicators were used to measure the degree of sustainability of the supply chain: economic, environmental and social.

Economic Indicators

Economic indicators were selected after taking into consideration all the issues and criteria mentioned above and aimed to capture the most important inputs-outputs of potato enterprise/business financial operation.

- *Variable Costs,* in £/tonne fresh potatoes. Include costs that are related with the volume of the crop (farmers) or the product as it moves along the supply chain.

- *Fixed Costs,* in £/tonne fresh potatoes, such as labour, machinery and rent.

- *Gross Margins,* in £/tonne fresh potatoes. Defined as the result of Turnover - Variable Costs. Gross margins should be positive even in the short-term.

- *Net Margins,* in £/tonne fresh potatoes. Defined as the result of Turnover - Total Costs. Net margins need to be positive over the medium to long term.

Environmental Indicators

Environmental indicators captured the most important aspects of natural resources management and environmental pollution of fresh potato supply chain.

- *Energy Consumption,* in MJ/tonne fresh potatoes. Energy consumption is assessed because of the limited resources of some energy sources (e.g. oil, gas) and the emissions to air for its production.

- *Water Consumption,* in m^3/tonne fresh potatoes, for crop irrigation and potato washing by merchants. Limited water resources may threaten mainly farmers' incomes in the future, as irrigation is very important to produce high quality potatoes especially in dry seasons.

- *Wastes,* in kg/tonne fresh potatoes, mainly on product. Reducing fresh potato wastes, especially during storage period, is a key issue for the supply chain and one of the most important targets of British Potato Council, in particular. Data relevant to other wastes generated at the supply chain, such as packaging material, could not be obtained.

- *Emissions to environment.* Several emissions to air, water and soil were selected in this study according to the stage of fresh potato supply chain. At the farmer stage emissions come mainly from the fertiliser and pesticide application, and fuel use, while at merchant and retailer stage the transportation, storage and packing of fresh potatoes are the main sources of emissions. The data collected are in various units of measurements according to the indicator.

Social Indicators

Social indicators dealt with the most important and easily quantified social aspects of the fresh potato supply chain.

- *Labour*, in hrs/tonne fresh potatoes, of the labour force (skilled or unskilled, permanent or temporary) used at each stage of the supply chain. The food supply chain, in general, provides employment to large numbers of people, especially at rural areas. Thus, it is relevant to measure the labour use of fresh potato supply chain.

- *Personnel training,* refers to the training of labour force involved in the supply chain of fresh potatoes. It is measured in hours of training for each employee/year. Personnel training is very important to the whole supply chain in order to meet consumer demands in an efficient and effective way.

Social capital aspects such as relationships between the participants in the supply chain could not be explored in the quantitative survey, hence they were assessed by the qualitative survey, as described later.

3.4.2. Sample of the study and data collection of quantitative survey

The sample of the study was the participants of the supply chain farmer-merchant-major retailer-consumer. The rationale behind this decision is the fact that this supply chain accounts for the 75-80% of total retail fresh potato sales. Moreover, the aim of the research was to study the sustainability of the fresh potato supply chain over time. Although it was feasible to collect data to describe the performance of the supply chain against selected sustainability criteria at the present time, it was found that this was difficult for conditions 10 years ago. Thus, the quantitative survey focused on the performance of the supply chain at the present time only and also showed an application of the analytical framework.

The data selected for farmers are from secondary sources and farm management handbooks. However, considerable information for standard estimates was found from several other sources, such as applications of environmental life cycle assessment for agriculture. Secondary data was chosen because they give representative values, while data from a particular potato farm case study may not be necessarily representative of common circumstances and practices.

Secondary data could not be found at merchant stage, and only few were available from the environmental reports of some major retailers; hence case studies on a selected large potato merchant and a major retailer were carried out. The collection of data proved difficult for merchant and even more so for retailer. The problems of data collection were related with the level of detail required, the different data classification systems used by different stages, and the concern not to exhaust the goodwill of the participants as parts of data collection process were time and effort consuming and raised issues of commercial confidentiality. The data selected from the merchant gave a holistic picture of the business performance in terms of the selected sustainability

criteria. However, the data selected from the major retailer were not enough to get a comprehensive picture about that business performance, even though much time was spent trying to obtain relevant data.

3.4.3. Data analysis of quantitative survey

The results (e.g. costs in £s or energy in MJ per tonne of potatoes sold to consumer) of each indicator for all activities were aggregated for each stage and for the whole supply chain. Then, these aggregated measurements were interpreted taking into consideration the Sustainable Development Records (SDR) method. This method allowed assessing the performance of supply chain according to key sustainability criteria (indicators) related with inputs – processes – outputs of the fresh produce supply chain. The SDR methodology relies on the development of key SDR indicators, which are a quotient with a numerator and denominator in accordance with the economic logic of the SDR analysis and independent of scale (Nilsson et al, 1998).

The SDR key indicators used in this study to assess the performance of supply chain were distinguished as follows:

- Input Efficiency. What is the efficiency of the supply chain in using various resources (inputs) for the production, distribution and retailing of fresh potatoes? Efficiency indicators include: variable, fixed and total costs (economic indicators); energy and water consumption (environmental indicators); and labour requirement (social indicator), expressed per unit of output.

- Output efficiency. What are the impacts (outputs) of supply chain on natural resources and society? These are gross and net margins (economic indicators); emissions to environment and waste production (environmental indicators); and personnel training (social indicator), expressed per unit of output.

- Allocation. What is the contribution of each stage of the supply chain in each indicator? (e.g. how much CO_2 is emitted at the production, distribution or retailing?)

Although, there are some sustainable measures to benchmark farm or business performance in terms of emissions to air, water and soil (Leiva, 1997), many of the sustainable benchmark measures are subjective and cannot be widely applied because they do not consider the special circumstances of each farm or business operates. Thus, it is potentially more useful to set the performance of potato enterprise or business in a selected year as a benchmark and then to monitor and evaluate the performance of potato business in the following years according to the benchmark performance (Eco-Compass, see §2.3.4). In this way, changes in the degree and direction of sustainability can be assessed. Sustainability indices (Andreoli et al, 2000) and optimization models (Callens et al, 1999) could also be used to analyze the data collected. However, the former method implies the use of weightings, the selection of which is subjective and the latter can become very complex and complicated raising difficulties for end-users to fully comprehend the assumptions made and easily appraise the results.

3.4.4. Findings of the quantitative survey

The quantitative survey aimed to assess the changes in the performance of the fresh potato supply chain between 1990 and 2000. Although it was to an extent feasible to collect data about the sustainability of the supply chain in 2000, it proved difficult to do so for a decade ago. Thus, the survey focused on the present situation to show the application of the analytical framework.

Appendix 5 reports the findings from the assessment of fresh potato supply chain performance according to the selected economic, environmental and social indicators using 1 tonne of fresh potatoes bought by consumers as a measurement unit. The findings from the quantitative survey are presented in three headings: input efficiency (§A.5.2.1), output efficiency (§A.5.2.2) and allocation indicators (§A.5.2.3). The sources of data used and the assumptions made to assess supply chain performance are also show in detail in Appendix 5 (Tables A.5.1 to A.5.18). Recommendations (§A.5.2.4) are also made for the further development and application of the analytical framework.

The assessment of the performance of fresh potato supply chain according to the selected input and output efficiency quantitative indicators in 2000 explored the degree of sustainability of the supply chain. However, the assessment in 2000 could not draw any conclusions on how more or less sustainable is the supply chain than in 1990, because there was considerable lack of data for that year.

The survey revealed (Figure A.5.1 and Table A.5.19) that the farm and merchant stages are responsible for most of the energy consumption and CO_2 emissions in the supply chain. Water is used mainly to irrigate potatoes and to a much lesser extent to wash potatoes at the merchant stage. The merchant stage is the most labour intensive in the supply chain and it also accounts for the great majority of fresh potato wastes, followed to lesser extent by the farm stage.

It was anticipated that the quantitative survey would assemble important information about the changes in the performance of the supply chain in an objective manner provided the data collection problems could be overcome. Unfortunately, for reasons beyond the control of the researcher, this proved to be infeasible in the time available. Thus, it is recommended that this analytical framework is further developed and applied in the fresh potato supply chain on a regular basis in the future by supply chain participants or governmental agencies. This could provide ongoing monitoring and evaluation of the changes in the supply chain in a quantitative way.

3.5. Qualitative Survey

The qualitative survey aimed to provide explanation about the reasons behind the changes in the performance of fresh potato supply chain in terms of economic, environmental and social criteria during the last decade. It used a postal questionnaire because it aimed to elicit the perceptions of a large number of participants at each stage of the supply chain. The questionnaire assessed the importance of factors that influence actor's behaviour, and consequently supply chain performance. Moreover, it searched for changes in the performance of potato businesses at all stages of the supply chain, especially those which could not be easily quantified, like product quality, relationships

and application of Efficient Consumer Response (ECR) concepts (Pearce, A., 1996; Pearce, T., 1997; Harris et al, 1999). Finally, conjoint analysis was applied to explore the relative importance of economic, environmental and social criteria in the farmers', merchants' and retailers' choices for fresh potato supply chain systems (Appendix 2, 3 and 4).

Several methods and models were considered for the qualitative research. The Theory of Planned Behaviour (TPB) of Ajzen and Fishbein (East, 1990) can provide useful insights to identify the main factors influencing the behaviour of the participants of the supply chain and consequently its sustainability. According to TPB the behaviour is related to intentions to behaviour and in some cases to perceived behavioural control (the perception of personal constraints to carry out a task (e.g. financial limitations, lack of knowledge)). The intentions to behaviour are a function of attitudes, subjective norms (what the others require from us to do) and perceived behavioural control (Beedell and Rehman, 2000; Lynne et al, 1995).

The application of TPB requires a single behavioural measure, however, the author of this thesis believes that there is no single behavioural measure of sustainable performance. Thus, TPB could not be applied in this study; however, it was used to consider in a systematic way the factors influencing the sustainable behaviour of the participants in the fresh potatoes supply chain.

3.5.1. Questionnaire of qualitative survey

The desired outcomes of the questionnaire, the number of questions that should be included and the concern not to exhaust the good will of the respondents were factors considered in the selection of criteria for the qualitative survey. Thus, it was deemed that the selected criteria should capture the most important issues regarding the economic, environmental and social aspects of the supply chain. Initially, the selection of criteria to explore participants' attitudes towards the sustainability of their potato business during the last decade was based on past studies and mainly on the in-depth interviews carried out with selected representatives of actors in the supply chain. The

initial set of criteria was refined through further discussions with participants on the supply chain.

The questionnaire for the qualitative survey consisted of several common questions, which varied slightly according to each stage of the supply chain and were conceptually split in 8 groups (Box 3.1). The first 3 groups of questions dealt with the factors influencing respondents' decision making with respect to their potato business (research question-objective 3). These factors were respondents' attitudes for the importance of sustainability criteria in their decisions management (such as profitability, environmental pollution, business uncertainty), other people or organisations influencing respondents (such as government, retailers) and factors preventing improvement of performance (such as lack of labour skills, adequate natural resources (irrigation, soil), uncertainty).

Box 3.1. Questionnaire Design

The questionnaires sent to farmers, merchants and retailers consisted of the following groups of questions (Appendices 2, 3 and 4):

- Attitudes for the importance of sustainability criteria
- Influence of other people or organizations
- Limiting factors on business performance
- Self-assessment of business performance during the last decade
- Future actions for business performance improvement (Only for farmers)
- Business Profile
- Actions taken to improve business sustainable performance
- Conjoint Analysis

The fourth group of questions asked from respondents to self-assess the changes in the performance of their enterprise according to selected sustainability indicators during the last decade (research question-objective 2). Moreover, it aimed to elicit respondents' opinions about the trade-offs between sustainability elements (economic, environmental and social), the potentiality of organic farming improving both economic and environmental performance and whether deregulation of potato industry has been beneficial to them.

The next group was addressed only to farmers and its aim was, among others, to elicit farmers' attitudes towards a number of actions that could potentially improve the sustainability of their potato enterprise in the next decade, as well as to find out what farmers thought about some aspects of the future of fresh potato production (research question-objective 4).

The business profile questions allowed exploration of any potential association between business characteristics and respondents' perceptions of their potato business sustainability (research question-objective 3). Another group of questions explored whether respondents have taken any actions to improve the sustainability of their business and the answers to these questions they were also used to explore whether there was association between taking such actions and respondents' perceptions of the sustainability of their potato business (research question-objective 3).

The last question used the method of Conjoint Analysis to identify the relative importance of economic, environmental and social performance on the way respondents manage the fresh potato production, distribution and retailing systems (research question-objective 3).

The trial questionnaire was further discussed with some volunteer respondents from every stage of the supply chain in order to investigate any troubles in filling in the questionnaire. The trial tests revealed that farmers faced particular difficulties in filling in the conjoint analysis question (described later), thus, it was decided to send the conjoint question separately (second phase) to those farmers that responded to the initial questionnaire including another question (future actions question) in order to find out if the whole sample would face such difficulties. The conjoint question was also sent

separately (second phase) to merchants for the reasons mentioned above. However, it was considered that sending to retailers the conjoint question separately would probably result to very small set of data collected for the conjoint analysis and thus the conjoint question was included in the main body of the questionnaire.

In order to increase the response ratio of the postal survey farmers were offered the chance to win a prize once they completed and returned the questionnaire. The prize comprised a day's consultancy by the staff of Cranfield University at Silsoe on some aspect of farm land, business or marketing management. The winner opted for advice on a potential reservoir design and investment. All participants in farmers, merchants and retailers' survey were also offered a personal summary of the survey results when they are ready once they indicated that they would like to receive it.

Attitudes

It was appreciated that the number of criteria selected should be around 10 to 13 in order not to exhaust the good will of the respondents, but to include the most important criteria that farmers take into consideration in their decision-making. Moreover, they covered aspects of all three dimensions of sustainable development, namely economic/financial, environmental and social (Appendix 2, 3 and 4). Constructs included business uncertainty which includes economic (profitability), environmental (increasingly stricter environmental legislation) and social (e.g. trust in relationships) aspects.

Questions 1 and 2 (Appendix 2, 3 and 4) asked respondents how important were the selected factors in their management decisions for their potato enterprise or business at the present time and 10 years ago, i.e. 1990, respectively. Respondents were asked to indicate the alternative that best reflects their feeling on the 5 point Likert-scale provided (not at all, little, moderately, a lot, extremely).

The reason for exploring respondents' attitudes at the present time and 10 years ago, was to find out any potential changes in respondents' attitudes for the importance of sustainability criteria in their decisions management. These changes in attitudes

could also explain any changes in potato enterprise or business performance in terms of the selected sustainability indicators. It could be argued that asking respondents about their attitudes of 10 years ago would not obtain very reliable results, as it would be very difficult to remember very well how she/he thought a decade ago. However, it was considered that taking into account the several and very important changes that have taken place in the fresh food supply chain during the last decade, the 'double' question could capture the trends in attitudes change, which in turn influenced changes in the enterprise/business performance.

Influences

Questions 3 and 4 aimed to find out what was the importance of the influence of selected people or organisations on the way respondents manage their potato enterprise at the present time and 10 years ago, i.e. 1990, respectively. Thus, this 'double' question tried to identify any potential changes on the relative importance of the selected people or organisations influencing the participants of the supply chain. Moreover, these changes in influences importance could help to explain any changes in potato enterprise or business performance in terms of the selected sustainability indicators. The format of these questions and the way people or organisations were selected, were similar to those described in the 'attitudes' section above.

Limiting factors to performance improvement

Questions 5 and 6 aimed to find out what respondents perceived to be the importance of selected factors in limiting or constraining the performance of potato business and consequently its sustainability at the present time and 10 years ago, i.e. 1990, respectively. The format, the rationale behind these questions and the way factors were selected were similar to those described in the 'attitudes' section above.

Self-assessment of enterprise performance over time

The sustainability indicators selected to self-assess the changes of potato enterprise performance during the last decade were mainly qualitative in manner. They reflected the findings of the literature review and of the exploratory survey (in-depth interviews) and covered the most important aspects of all three dimensions of sustainable development regarding fresh potato supply chain. Respondents were asked to indicate how much they agree or disagree with the selected statements about their potato business on the 7 point Likert-scale provided (from totally disagree to totally agree) (Appendix 2, 3 and 4). A 7 point scale was preferred to the 5 point scale used in the previous questions in order to capture the changes in performance in the spectrum from negative to positive, but factors' importance in respondents' decision making were captured in absolute terms of importance, from not at all important to extremely (either positive or negative) important.

Actions for the future

The actions and aspects of the future were selected after taking into consideration the findings of the literature review and the exploratory survey and covered all three dimensions of sustainable development. Farmers were asked to indicate how much they agree or disagree with the selected statements about the future of their potato enterprise on the 7 point Likert-scale provided (from totally disagree to totally agree) (Appendix 2, 3 and 4).

Profile

Participants of the survey were asked also about the size and type of their potato business, and the sources and destinations of their potatoes, if relevant.

Actions taken to improve sustainability of business

The actions selected to explore whether respondents have taken any measures to improve the performance of their potato enterprise or business dealt mainly with environmental and social aspects. Although, there was a variation in the environmental related selected actions according to which the questionnaire was addressed (farmer, merchant or retailer), these included, among others, carrying out environmental audits, applying farm assurance schemes (FAS) (for farmers) or buying potatoes produced under FAS (merchants and retailers), and increased level of investment on their business on key areas of environmental interest. The social related actions were participation in growers, merchants or retailers association and the existence of staff development programmes in their business (Appendix 2, 3 and 4).

Conjoint Analysis

Conjoint Analysis was used to explore the relative importance of economic, environmental and social performance on the way respondents manage the fresh potato production, distribution and retailing systems. The general hypothesis of the conjoint analysis was that the choice made by growers, merchants and retailers for a particular production or supply chain system for fresh potatoes was based on the three components of Sustainable Development, namely, economic, environmental and social performance. Alternative production or supply chain systems, or 'scenarios', were described in terms of having different economic, environmental and social performance, and growers, merchants and retailers were asked to indicate their relative preference accordingly. It was assumed that there is very little correlation between the attributes namely, economic, environmental and social performance, as there were significant distinctions in their definitions. Three levels were chosen for each attribute (low, medium and high) and definitions of each attribute at each level were provided to help respondents better answer the questions (Appendices 2, 3, and 4).

The next step of conjoint analysis was the specification of the conjoint model. It is assumed that the respondents of conjoint analysis research, in general, implicitly combine the 'part-worth' evaluations of each attribute to reach to the overall

'evaluation' or overall preference of the scenario proposed. There are two forms used to describe this compositional form of conjoint analysis. The additive model assumes that the overall evaluation of each scenario consists of the separate part-worths of the attributes (Hair, et al, 1992). Thus:

Total worth of a product $_{ij\ldots n}$= Part-worth of level i for attribute 1...+

Part-worth of level j for attribute 2...+

Part-worth of level n for attribute m

where the product has m attributes each having 2 or more levels (Hair, et al, 1992).

The interactive model assumes that, although the respondent usually adds the attribute part-worths to get an overall total evaluation on a scenario, for some certain combinations of attribute levels the overall total evaluation may be more or less than their sum. The additive model is simpler to be applied and more frequently used than the interactive. Moreover, Hair et al (1992) suggests that the interactive model seldom has a significant better fit to the data.

The next model specification had to do with the way that the levels of an attribute are related to each other. From the three possible relationships, linear, quadratic and part-worth form, the part-worth is the least restrictive as it does not pre-specify the part-worth relationship (Hobbs, 1995). The linear model is the simplest but the most restricted as it assumes a strictly linear relationship between consecutive levels of an attribute. Finally, the quadratic model assumes a curvilinear relationship.

For the purposes of this survey, the additive model with linear relationship of part-worths was assumed. This is because it seemed that more complicated models would not have given more meaningful results, as the results were, to great extent, influenced by the interpretation that respondents give to the attribute level (e.g. low economic performance, high social performance) definitions and thus trends of the relative importance are sought for than actual numbers.

The next step after choosing the attributes and their levels, and specifying the form of the conjoint analysis was the design of the scenarios. The number of scenarios

depends on the numbers of attributes and attribute levels. In the case of 'full factorial' design, where all attributes were included in each scenario, the overall number of possible scenarios would have been 3^3=27. Hobbs (1995) refers that the number of scenarios that a respondent could evaluate should be between 9 and 16, thus the full factorial design could not be applied in this survey. The problem caused by the great number of alternative scenarios of full factorial design can be overcome with the help of 'fractional factorial' designs, which assume that some interactions between attributes are insignificant and can be omitted. Fractional factorial designs yield a smaller number of scenarios than the full factorial, which capture the main effects of each attribute with no interaction between attributes. Fractional factorial designs are created by software computer programmes, like SPSS (1998), and in case that unacceptable scenarios are produced then a new subset of scenarios is generated.

The full factorial design would generate 27 scenarios in this survey, and thus a fractional factorial design consisting of 9 scenarios plus 2 hold-out scenarios were generated by SPSS. Hold-out scenarios were evaluated by respondents, but the data derived by them were not included in the computation of the part-worth values of the attributes. Instead, these data were used to compare the accuracy with which the model predicted each respondent's preference score for the hold-out scenarios. Each scenario was checked to ensure that it did not consist of unrealistic combinations of attribute levels.

The next step was to choose a data selection option. The full profile approach was preferred to 'two-at-a-time' in this survey because it requires fewer judgements from the respondent and the scenarios are more realistic. However, the respondent has to make more complicated judgements, thus the overall number of attributes should not exceed 6 (Hair et al, 1992). Thus, a subset of alternative scenarios was presented to the respondent each of which includes one level of each attribute.

Respondents may show their preference for a hypothetical scenario either by ranking the hypothetical scenarios from the least to most preferred or by rating their strength of preference for them according to a metric scale (e.g. 1 to 9). It is difficult to use ranking for a postal survey because of the probable confusion caused to the respondents to sort a number of hypothetical scenarios into their preferred order.

Moreover, Darmon and Rouzies (1999) found out that some important estimation biases occur for rankings and for rating scales containing fewer than seven points, and that rating scales with seven or more points tend to provide the most accurate results for estimating attribute importance weights. However, Hair et al (1992) mention that rating technique runs the risk for the respondents to be less discriminating in their evaluations of alternative scenarios than when they are forced to rank them from the most to least preferred. For these reasons, it was decided the rating technique of 9 points to be used.

3.5.2. Sample of qualitative survey

The sample of the study, as mentioned before, was the participants of the supply chain farmer-merchant-major retailer-consumer. The study focused mainly on the farmers with relatively big potato enterprises. In consultation with British Potato Council and taking into consideration potato statistics, the main criterion of such farmers was that they produce more than 10 hectares of potatoes.

The British Potato Council kindly selected a sample of 1000 farmers according to this criterion from its database. The questionnaire at this phase excluded the conjoint analysis and the future actions questions. Moreover, for confidentiality reasons BPC undertook to send and collect the questionnaires using a coding system that only they knew in order to send a summary of the questionnaire results to those farmers who wished to receive a copy and to send also the second part of the questionnaire. The response ratio was high (24%) and 240 answered questionnaires were returned allowing the production of statistically significant results. The selection of the sample was very successful, as 93% of the respondents applied a farm assurance scheme, which is prerequisite to supply major retailer.

Using the data from the profile questions a sample of 80 farmers was selected for the second phase of the survey. This was in order to keep costs in a minimum and to obtain a sufficient sample. Initially, farmers supplying more than 50% of their produce in the fresh market (i.e. not for process or seed) were selected and after these farmers were split in 4 groups according the potato production area, 20 farmers were selected

from each group. The code numbers were sent to the BPC, who in turn sent the second part of the questionnaire. 37 farmers responded to the second phase of the survey (response ratio of 46%). However, only 24 of them (30% of the sample) filled in the conjoint analysis questions, and 4 of the questionnaires were not fully or correctly filled in. Hence, 20 answers were considered in the statistical analysis. Thus, it seems that farmers faced particular difficulties to fill in the conjoint analysis question. Hence, it was considered that it was right to send the conjoint analysis question separately from the main body of the questionnaire.

The study also focused on those potato merchants/packers that supply the major retailers. British Potato Council identified all those merchants and thus, a separate questionnaire, excluding the conjoint question was sent to 28 merchants. 14 of them responded initially and 3 other after following-up telephone calls (60% response ratio). Several of the other merchants contacted mentioned that they never did or they no longer have business with major retailers. The conjoint question was sent to those that responded to the main body of the questionnaire. Ten questionnaires were received back and only 7 of them could be statistically processed. The response ratio was very high for a postal survey; however, it was obvious that respondents faced difficulties in filling in the conjoint analysis question.

A list of fresh potato buyers of major retailers was obtained with the help of an executive officer of Fresh Produce Consortium. 8 potato buyers of 8 major retailers were sent the questionnaire, including the conjoint question, and 4 of them responded. The response ratio was high (50%); however, it is probable that if the conjoint analysis question was sent separately the response ratio might have been higher. Generally, it is felt, however, that retailers are often reluctant to respond to external enquiries about matters that they regard as commercially sensitive.

3.5.3. Data analysis of qualitative survey

Most of the data derived were collected by Likert-type scale, thus non-parametric tests were used for statistical analysis (Field, 2000). The Friedman test was

used to find out if there was significant difference among the means of the selected factors and their relative importance was also ranked. Descriptive statistics, such as mean, median, mode and standard deviation, and frequencies statistics (valid percent) were also found useful to show the relative importance of factors on the potato business sustainability. Mean and standard deviation are theoretically statistically meaningful only for data measured at interval or ratio scale, which is not the case for Likert-type scale used in most of the questions (Field, 2000). However, such statistics were found useful in this research to better show the differences of factors importance and thus they were used with caution. The Wilcoxon Signed Ranks Test also showed if there was significant difference (increase or decrease) in the importance of factors between 1990 and 2000. The Mann-Whitney test was used for identifying potential differences in the means of respondents' classes according to selected sustainability action such as, for example, farmers who participated or did not participate in a growers' association. Moreover, the Kendall's tau b test was used to find potential the correlation between the selected sustainability actions and respondents' perceptions about the sustainability of their potato business (Field, 2000).

The SPSS Conjoint procedure (SPSS, 1998) was used to explore the relative importance of economic, environmental and social performance on the way respondents manage the fresh potato production, distribution and retailing systems. The SPSS Conjoint software produced the 'part-worth' evaluations of all levels (low, medium, high) of each attribute (economic, environmental, social performance) at an individual level and for the whole sample. Pearson's R correlation coefficient and Kendall's tau statistic were also calculated to evaluate the reliability of the model. Descriptive statistics, and the Friedman and Wilcoxon Signed Ranks tests were also used to better describe and explain results from conjoint analysis. Moreover, Hierarchical Cluster and Cluster K means analyses were carried out to find clusters of respondents with similar attitudes to the importance of economic, environmental and social performance.

3.5. Critique of the Approach

The main limitations of the research methodology reflect to the practical difficulties of carrying out the in-depth interviews, the quantitative survey and the qualitative survey on the subject matter. Such limitations derive from defining sustainability; selecting key representatives at each stage of the supply chain; choosing the most important and relevant sustainability indicators to assess supply chain performance; selecting the most important factors that influence participants' behaviour and actions in terms of the sustainability of their business; assessing sustainability over time; the use of case study approach; and the reliance on secondary data resources.

The approach attempts to cover sustainability issues of the fresh potato supply chain as thoroughly as possible. In this respect, the study is based on extensive literature review of relevant topics and on the opinions of some key representatives of all stages of the supply chain. Although, it was feasible to meet with several farmers while carrying out the research, only a few merchant and retailer representatives were willing to participate in the survey, partly because of time pressures, but also because of issues of confidentiality.

Choosing the most important and relevant sustainability indicators to assess supply chain performance, and selecting the most important factors that influence participants' behaviour and actions in terms of the sustainability of their business was difficult. The number of sustainability indicators and factors that influence sustainability needed to be kept small so as not to exhaust the good will of the participants in the survey. However, important aspects of the sustainability of the supply chain should not be missed, and both the indicators and factors that influence sustainability should be credible from the viewpoint of various stakeholders. Although, the selection of sustainability indicators and factors that influence sustainability was made under the consultation of some representatives of the supply chain, it could be judged that it is, to some extent, subjective in manner.

Almost all the sustainability indicators and the factors that influence sustainability selected for the qualitative survey are constructs consisting of several components. This helped to include several sustainability aspects in the qualitative

survey. However, the use of constructs hide variation in meaning and further studies could focus on selected aspects and identify underlined factors. For example, the relationships in the supply chain could consist of norms of behaviour, trust and shared values and duty of care.

Assessing the sustainability of fresh potato supply chain over time also posed significant limitations. It was difficult to collect any reliable data to assess supply chain performance in 1990. Moreover, the results of the qualitative survey may suffer from reliability because of the time bias, since the respondents are asked to compare their business performance between 1990 and 2000, and also recall the importance of several factors influencing their decision making in 1990.

The quantitative survey is based on average values such as crop yields and use of inputs at farmer stage and on case studies at merchant and retailer stage, and there is risk of generalisation because variability across the stages of the fresh potato supply chain is not considered. The quantitative survey also relies on secondary information and results often undertaken for purposes different to those of the present study, especially at farm stage. In this respect, the literature review was focusing on standard estimations and values related to British potato farming. The assessment of the performance of the supply chain in 2000 (quantitative survey) could not be completed because some data were not available, or if they were available they were not accessible to the author, especially at retail stage.

Budget limitations also prevented from sending the second part of farmer questionnaire (conjoint question) to all participants of the first part. Statistical analysis was carried out, but the results could be more reliable if the questionnaire was sent to all farmers. Nevertheless, the response rate to the second phase of the postal survey (46% for both questions, 30% for conjoint question) was good by any standards.

This research is exploratory in nature. With this in mind, not withstanding the criticism and limitations of the approach, the findings of the study for the purposes intended are regarded valid and justifiable.

3.6. Summary of Chapter

This chapter dealt with the framework developed to assess the sustainability of fresh potato supply chain. The developed framework is conceptually based on the DPSIR model. The aim of in-depth interviews, as well as of the quantitative and qualitative part of the framework is presented. Moreover, an overview of the application of developed framework on the fresh potato supply chain is made. The next chapters deal initially with the findings of the in-depth interviews, followed by the quantitative survey and farmers', merchants' and retailers' qualitative survey.

CHAPTER 4

IN – DEPTH INTERVIEWS AND THE DPSIR FRAMEWORK

4.1. Introduction

This chapter deals initially with the main findings from the in-depth semi-structured interviews with farmers, merchant and retailer representatives, and consumers about the sustainability of fresh potato supply chain during the last decade. Afterwards, these findings coupled with the literature review are used to apply the DPSIR framework to the sustainability of fresh potato supply chain.

4.2. Farmers' Interviews

The main characteristics of producing potatoes for the fresh market and the main changes in the fresh potato supply chain during last 10-15 years were initially explored with farmers. Farmers' first comment about the structure of their industry is that the number of those involved is steadily decreasing. Moreover, they mentioned that the regulatory burden is becoming heavier over time. Regulations change very often and the changes in the supply chain are very frequent. Thus, farmers perceived that the education level required by those staying in potato farming is now much higher in order to help understand and address the new and ever changing market challenges. Farmers also mentioned that the critical size of a potato enterprise to stay in business (to bring sufficient profits) has more than doubled in the last 20 years.

Farmers also said that producers with large potato enterprises (more than 30 or 40 hectares annual potato cultivation) prefer to sell almost their entire crop to merchants that supply potatoes to major retailers, while farmers with small potato enterprises are usually the ones that supply open markets and small independent greengroceries. However, the farmers interviewed complained that they have no direct contact with major retailers, except the 'open days' organised by the retailers. The number of

merchants is also steadily decreasing, thus farmers felt that the remaining merchants have very great negotiating power against farmers. Farmers also mentioned that there are not any official contracts for fresh potato produce between farmers and merchants or retailers, but merchants and farmers usually make gentlemen's agreement about the potato variety and volume, and the time the crop should be delivered to merchants. In general, farmers seemed to be unhappy from their low negotiating power and they would wish to have stronger and closer relationships with the other participants of the supply chain.

Farmers said that major retailers gained significant negotiating power and retailers increased considerably their knowledge of consumer demands during the last decade or so, and hence major retailers are perceived to be responsible for most changes in the supply chain. Farmers said that, although, they have to apply compulsory farm assurance schemes in order to supply to major retailer, there is a plethora of farm assurance schemes for each crop. Farmers found this painful, as they have to spend valuable time and effort to keep records in various forms. The farmers interviewed kept records for all inputs they use and applications made because of the farm assurance schemes. The only exception was energy consumed.

Farmers mentioned that the pace of changes for both processing industry and fresh potatoes market has increased dramatically during the last decade. Nowadays, the market demands improved quality, reduced price and consequently reduced cost of production. Farmers found that potato farming now relies much more on mechanisation than 20 years ago and thus, the total number of people employed in farm has dramatically decreased.

Farmers stressed that until 10 years ago they could sustain financial losses at some years from their potato enterprise because there were 3-4 years out of 20 that profits were very high. Nowadays, farmers perceived that they need to have stable, though moderate, positive financial outcome every single year to stay in business.

Farmers also mentioned that they must produce true records for merchants otherwise merchants would never buy their crop again. This would leave farmers to sell potatoes on an uncertain open market or to independent greengroceries in the future,

which is perceived not to be desirable by producers with large potato enterprises. The type and quantity of pesticides that farmers can use is defined by the farm protocols, which are usually adequate to protect their crop from diseases. As a result farmers thought that, nowadays, environmental issues are of great importance in their decision-making and there is better water management and more prudent use of fertilisers and pesticides than in the past.

Farmers have also to take into consideration farm physical constraints like type of soil and irrigation availability. Access to irrigation is very important to produce high quality potatoes. Market demand and the outlet of the product is another important factor, thus, farmers have to look the trends of the next 2-3 years.

Moreover, farmers noticed that nowadays it is better and more convenient for farmers with large potato enterprises to focus on the production of potatoes which merchants and, especially, retailers require, because merchants and retailers know better than farmers about market demands.

Farmers believed that the main drivers for changes in the supply chain are consumers and government, which are also influenced, among others, by environmental lobbies. Consumers influence retailers who in turn influence packers and finally farmers.

Farmers thought that consumers perceive that food production does not differ from the production of industrial goods. Thus, consumers are perceived to demand vegetables produced without pesticides, having uniform appearance, of adequate quantities all over the year and lower in price over time. One of the farmers suggested that private or public organisations should better inform consumers about the consequences of their demands for food products on the environment and the food supply chain.

The participants in the interviews said that merchants are more important than retailers for farmers because farmers come in direct contact only with merchants. Merchants monitor also crops 'on behalf' of retailers.

Farmers mentioned that retailers set higher standards than those required by legislation in order to achieve marketing advantage over other retailers. This marketing advantage is perceived to help retailers attracting new customers from their competitors and also making existing customers more loyal to them.

Farmers also mentioned that their own attitudes and perceptions to sustainable development (e.g. self-commitment to inherit better environment and society to their children) play significant role to adopt production systems that improve their farm, in general, environmental and social performance.

4.3. Merchants' Interviews

Merchants' interviews initially dealt with the main characteristics of procuring, packing and marketing fresh potatoes, and main changes in fresh potato supply chain during the last 10-15 years. Merchants reported that very significant changes have taken place in the fresh potato supply chain in the last 10-15 years. The number of growers and merchants has fallen dramatically, while major retailers sell the great majority of fresh potatoes volume. Thus, the larger merchants have moved almost their entire trade to major retailers from the wholesale market.

Merchants also mentioned that nowadays the supply chain is market driven, while 10-15 years ago it was mainly production driven. Moreover, those people or businesses involved in the fresh food supply chain at the present, and especially major retailers, prefer to work in a more integrated manner with their partners from other stages of the supply chain because they can better achieve product quality control and traceability, ensure the availability of sufficient potato volumes around the year and reduce production and operational costs.

Thus, in the past, farmers produced potatoes that they thought the market wanted and then tried to sell them in the market. Now farmers grow mainly potatoes that are specified by merchants and major retailers.

In the past merchants were buying fresh potatoes for packing from the spot market. Nowadays, merchants said that they have developed links with a limited number of farmers with large enterprises, who can produce potatoes that meet retailers' requirements, and they also achieve economies of scale (cost reduction). Merchants have annual procurement program for the supply of their customers and thus, they make recommendations to farmers related to the cultivation area, varieties and the time potatoes should be delivered to them.

Merchants reported that retailers wish to reduce their own transaction costs. Thus, retailers have encouraged existing merchants to work with, or merge with, other merchants. Thus, according to merchants' views, the relationships in the supply chain are also much closer than before, as there are fewer people involved in the supply chain.

Merchants keep records for the quality assessments they hold. They also claimed to keep records for the packaging of potatoes, like the time it takes and the labour costs per tonne, as well as the water use and the energy consumption per month. For every consignment of potatoes coming in there is a purchase number. When the potatoes are unloaded they are weighed, quality control assessed, washed and size graded. Most of the potatoes go for storage from November until the new potatoes start in early June. The quality of potatoes is also monitored during the storage period. When potatoes are to be sold to retailers, their quality is assessed again and they are packed. Samples are also checked for pesticide residues and there is documentation for this purpose.

Merchants mentioned that major retailers make different demands for product specifications. Some require up to 20 different lines according to the package, variety, price and purpose of usage. Retailers also require exclusivity in terms of these product differences in order to achieve competitive advantage. However, merchants mentioned that these differences mean additional costs for merchants because of the dedication of a special team for every retailer. However, merchants perceived to have benefits from meeting different retailer requirements, such as credibility and more business with these customers.

Merchants also mentioned that farming industry lags behind other industries in terms of health and safety, and training issues, but in recent years the gap has been

closed. However, merchants complained that they face difficulties in improving their workers skill base, because their businesses are located mainly in rural areas, with low labour availability. Simultaneously, local labour appeared to have few ambitions and to some extent limited capabilities.

With respect to the factors that are important in merchant decision making, the respondents mentioned that all major retailers encourage merchants to regard environment in all their activities as well as the activities of farmers. Traceability is perceived by merchants to be very important for all major retailers. Major retailers require merchants to adopt a registration process to monitor their performance and compliance with certain standards either by a third party audit or internal audit. Moreover, merchants said that they have to monitor potato crop 'on behalf' of retailers in order to examine if the crop meets the standards of the farm assurance scheme imposed by the retailer.

Merchants stressed that they have also to face great business uncertainty because there is no official (written) agreement between retailers and merchant. Merchants said that they make annual or biennial supply plans with retailers, but since the last delivery merchants do not know if they will supply fresh potato again to the same retailer or not. Moreover, merchants stressed that retailers prefer to minimise transactions with their suppliers and consequently retailers' supply base is reducing. One of the merchants said that contracts will probably become reality in the future, but this would require from the actors of all stages in the supply chain to open their accounting books to their partners.

Merchants stressed that, even though, potato quality, sufficient quantities, traceability and cost reduction are the most important factors influencing their decision making, environment related issues are increasingly becoming important in their management decisions. Until a decade ago environmental issues were perceived to be of very little importance. Nowadays, merchants claimed that they require farmers to comply with specified environmental and social standards without affecting the yield, the quality and the marketability of the product.

The merchants interviewed stressed that major retailers and consumers have been the main drivers for changes in the fresh potato supply chain during the last decade

or so. This is mainly because retailers are closer to market demands and this, coupled with relatively small numbers and with their great business size, renders retailers the most dominant stage in the supply chain in terms of negotiating power.

Merchants believed that retailers set high environmental standards because of consumers' pressures. It is also a response of retailers to the negative publicity their business gets by the media because they are perceived to squeeze the profits of other actors and because they have enormous bargaining power in the supply chain. Consequently positive environmental image is very good for retailer business. However, merchants once more complained that it is farmers and merchants that bear most of the additional costs of 'sustainable' fresh potatoes, while it is the retailers who can improve their image to the consumers.

Merchants also mentioned that their profit margins have been significantly squeezed over the last decade or so and they have become more efficient in running their business, achieved competitive advantage, reduced production costs and as a result added value to potatoes for their customers.

Merchants also perceived that the government prefers to leave businesses involved in the food supply chain alone to find the best ways to deliver food products that are safe for consumers and in sufficient quantities. Government is focusing more on defining standards (e.g. food safety and labeling, environmental protection) and monitoring that these are applied, but it is those engaged in the fresh potato supply chain that deal with novelty issues which address consumers' ever changing demands. Moreover, merchants said that they did not think that government would attempt to alter its role in the food supply chain issues in the near future.

Merchants mentioned that media and other pressure groups play rather important 'watchdog' role which influences the actors of the fresh potato supply chain. Thus, it is perceived to be of the interest of merchants to put structures and systems in place to avoid attracting the attention of media and other pressure groups which could cause negative publicity for those engaged in the supply chain.

Merchants' main concern was that consumption of raw potatoes is definitely declining. Other sources of starch like pasta and rice are increasing their market share. Moreover, merchants believed that the consumption of fresh potatoes will drop dramatically in favour of more processed and convenience products.

Merchants complained that most of the benefits of cost reduction go to major retailers and are not divided proportionally to the actors of the supply chain. For example, retailers ask from merchants to pack together the bags of potatoes in order to help them replenish easier their outlets. Although retailers benefit of this as they save time and money, they do not contribute proportionally to the additional expenses merchants bear.

Merchants also questioned why consumers place so much attention on the skin and uniform appearance of the potatoes, since they are going to peel them. Thus, merchants suggested that public or private bodies should better inform consumers about the effort, money, time and water for irrigation spent to make products more attractive.

4.4. Retailer Interview

The main characteristics of retailing and marketing fresh potatoes, and the main changes in the fresh potato supply chain in the last 10-15 years were initially explored with the representative of the major retailer. The respondent described the route map of fresh potatoes from reaching at the distribution centre until they are sold to consumers as follows: Retailers place order to merchant to pack potatoes, which are delivered to retailer's depot (distribution centre) after one day. The potatoes do not stay for more than a day at the depot. Then the potatoes are picked up early in the morning and are at the retailer's store by midday or afternoon. Then the product is displayed until its expire date (usually 3-4 days for potatoes), after which it is withdrawn if not sold.

The retailer representative stressed that for his business it is necessary to have a supply base capable to provide a range of products for the whole of the year to satisfy customers' needs. There is a whole range of potatoes with lots of varieties and different uses.

The respondent also stressed that 10 - 15 years ago merchants had no loyalty at all to the retailer and retailer bought fresh potatoes from the spot market. As the major retailer's business volume has increased it became obvious that a loyal and stable supply base was necessary to meet growing market demands. In fact, retailers needed to reduce costs, understand the cost structure, plan the volumes needed in advance and improve the efficiency of the supply chain. The organisation of the respondent now makes 5-year business plans, which are discussed in detail with suppliers in order to make the annual procurement programs. The respondent claimed that everyone involved in the supply chain that supply fresh potatoes to his organisation knows the costs of production throughout the entire supply chain. However, merchants and farmers had independently complained that retailers do not share with them other important market information.

Moreover, the respondent perceived that there are better and stronger working relationships now among the participants in the supply chain. He also mentioned that it is not possible to remove all risk and uncertainty in the food supply chain, but when merchants and farmers understand retailers' market needs, things become easier.

Environmental issues have become important in retailers' management decisions because consumer research revealed that agriculture is perceived to be a high input industry posing high risk to biodiversity and damage to the environment. Retailers also wish to avoid the media to focus negatively against them. The organisation realised that environmental issues had to be addressed in collaboration with its suppliers and thus this retailer decided to require from its suppliers fresh food produced only under farm assurance schemes. This was done to protect the brand name of the company, which is perceived to be one of the most important assets for the company.

The respondent claimed that farm assurance schemes could address two criteria for acceptance by consumers. First and most important, they require that the food product must be safe, without dangerous toxic residues. This challenges the need for the chemical application and scrutinises the use of these inputs. Second, they require that environmental risk is reduced and there is prudent use of natural resources. The respondent believed that farm assurance schemes were really very successful in this

respect because they made growers think about the environmental impacts of crop production, while simultaneously producing safe and high quality crops.

The respondent said that his organisation encourages not only farmers on the production phase, but also the distribution system (merchants) to make energy audits and they also do energy audit at their own facilities (e.g. depots, lorries, refrigeration).

The respondent said that his organisation's supply base for fresh potatoes has been reduced and now includes only 10-12 suppliers. They have worked with these suppliers for long time and there is a good understanding of each other's objectives and merchants deliver products that meet consumer standards.

Every 2-3 years, depending on supplier's performance, the marketing group of the organisation makes an audit of the merchants to approve the continued supply. They assess supplier's performance in terms of product quality and food safety. The organisation wants also to be assured that merchants can control their grower base so they can deliver to the supermarket everyday the volume required and achieve full traceability of the product. Then the retailer judges the volume that will be allocated to each supplier according to the performance.

The respondent believed that the major drivers for changes in the supply chain are the retailers themselves because they are part of the very competitive final market. The retailers need to retain and increase their market share, deliver good profits and share values to the shareholders.

The respondent said that his company continuously conducts customer research about the stores, the range of products and product quality. This process enables the marketing group to offer to consumers the product they would like to be offered. The retailer representative mentioned that media also influence considerably those involved in the supply chain because of their influence on consumers.

The respondent perceived that the government preferred to minimise its intervention in the market and leave market forces to lead the changes in the food supply chain as long as the food offered to consumers met legal requirements. This is because it would be more difficult for the government to impose and monitor the

application of high food quality and safety, environmental, and social standards, like those described in the farm assurance schemes. The respondent mentioned that the major retailers have very small supply base (merchants) and very close relationships with merchants, so major retailers can influence their partners very quickly and deliver the changes in the supply chain.

The respondent admitted that farmers are right to complain about the plethora of crop protocols they have to comply with, as well as that profit margins are very tight for those engaged in the supply chain. However, he mentioned that his organisation is working with others engaged in the supply chain to create a single audit scheme that can be used by all participants in the supply chain.

The respondent deemed that the competition will become even fiercer in the future and price reduction strategies will become more acute in the food retail industry. Nowadays, there is global and not only UK competition with the prospect of new entrants; Wal-Mart, for example, came from Europe and USA. The retailer's supply base has to become even more efficient in the future to help the retailer to be more competitive in the future.

Nationalism is also becoming very important as consumers prefer to buy British products, so the respondent's organisation supports local produce and imports are used mainly when the local produce cannot satisfy market needs.

4.5. Consumer Interviews

The factors influencing consumers' choice of fresh potatoes, and the people and organizations informing consumers about the economic, environmental and social impacts of the fresh food supply chain were explored with consumers. Consumers interviewed stressed that product quality is an important issue and it is more important nowadays than before. Consumers were not particularly aware of the environmental and social impacts of agriculture, and they do not consider these issues when buying fresh potatoes. Moreover, they stressed that consumers are not provided with any information with respect to the production system of the particular potatoes they buy. Price is an

important criterion for selecting potatoes. They also want potatoes reasonably clean, not to be damaged or with disease, otherwise they cannot be stored.

Consumers interviewed claimed to be little informed about the environmental and social impacts of crop production mainly by personal discussions with friends and relatives, newspapers and magazines, and television programmes, but not from major retailers. Moreover, they said that they were not aware of the crop protocols which major retailers imposed on British farmers. However, it should be mentioned that several major retailers highlight their efforts to impose crop protocols on the farming industry and their expected outcomes, in their websites related to sustainability or environmental topics. Nevertheless, none of the major retailers claimed to have made a wide campaign to inform its customers about the existence of crop protocols. Thus, major retailers imposed crop protocols mainly because of the Food Safety Act 1990 so that they could argue that they took all precautionary measures to sell only safe and wholesome food products to consumers. The crop protocols may have improved the environmental and social performance of crop production, but this was not the main reason that forced retailers to impose crop protocols.

4.6. Sustainability of Fresh Potato Supply Chain During the Last Decade: In-Depth Interviews and DPSIR Framework Application.

The interviews revealed that the most important channel in the supply chain for fresh potatoes is that of producer-merchant-major retailer-consumer and that the fresh potato supply chain is highly coordinated. Moreover, the Food Safety Act of 1990 and its 'due diligence' clause increases responsibilities of retailers and merchants to supply safe food products. Consequently, the drivers for changes in the fresh potatoes supply chain are similar if not identical at all stages of supply chain. The in-depth interviews revealed that retailers being closer to consumers and taking advantage the advance in Information Technology are perceived to know what consumers want. Thus, retailer's drivers for changes and retailers themselves become drivers to merchants and then to farmers.

The number of farmers, merchants and retailers that are still in the market has reduced dramatically over the last 10-15 years and the remaining have to work in an increasingly risky and insecure environment. The discussions with farmers, merchants and the retailer representative revealed that the changes in the supply chain in general and in terms of sustainability derive not solely from the retailers. Retailers have the power to impose changes in the supply chain and they do so. However, the participants in the interviews perceived that it is mainly consumers and governmental bodies that push retailers to impose changes in the supply chain by increasing their demands on the quality of fresh potatoes that consumers buy and demanding the supply chain to minimize the negative environmental and social impacts of potato production. Moreover, the competition in the retail sector is very strong. Consumers and governmental bodies are also perceived to be often influenced by non-governmental organizations, television and press, and international society. Moreover, the role and the power of merchants is also increasing as retailers have decreased the number of merchants they work with to a handful.

The interviews also revealed that sustainability issues are of considerable interest for all the participants of the fresh potato supply chain. It seems that food product safety and quality, employee health and safety issues, environmental risk and natural resources management have been among the most important factors that triggered most of the changes in the last 10 - 15 years in the fresh food supply chain.

A key feature of food production is now the use of crop protocols, which set the standards to be met when producing fresh potatoes. These protocols, developed by the major retailers, deal with the protection and enhancement of natural resources, wildlife and landscape, the use and conservation of natural resources, the protection of health and the use of chemicals. Moreover, the merchants conduct either internal or external audit on regular basis for environmental (leakage, wastes, water use, energy consumption), and health and safety issues. The retailer makes also internal audit of the same issues. However, consumers participating in the interviews claimed to be totally ignorant about the existence of crop protocols and were questioning how can they be sure that fresh potatoes sold by supermarkets are 'greener' than those sold by other outlets. This could be an issue for further investigation, why producers, merchants and

retailers do not adequately inform their customers about their major effort to minimize negative environmental and social impacts of their businesses.

Table 4.1 summarizes some of the key results derived from the application of the proposed framework to the fresh potatoes supply chain based on secondary data and findings from the literature review and the interviews with key players of the supply chain (Vasileiou and Morris, 2000). It refers to all the stages of supply chain, including farmers, packers and multiple retailers.

The DPSIR framework can help in understanding the interconnections between environmental and social and economic aspects, but it is not entirely appropriate for dealing with sustainable development (DETR, 2000). For example, according to DPSIR framework consumers' demand for higher quality, more convenient and cheaper food products would be regarded as driving force. However, the underlying driver is not merely consumers' desire for food products that meet these criteria, but the major changes that took place in the society during the last decades coupled with the advance in technologies that allowed the food supply chain to offer such products to consumers. Moreover, in several cases, there is not clear distinction between responses and drivers, pressures, state or impacts. The DPSIR framework does not also readily refer to issues like relationships between the partners of the food supply chain. Thus, this framework is used here as a conceptual basis to provide an overview of environmental, social and economic links and consider the sustainability issues of fresh potato supply chain in a systematic way.

Applying the DPSIR framework to describe the fresh potato supply chain in terms of sustainable development in the last decade, we find that the various drivers external (government, non-governmental organizations) or internal (consumers or retailers) to the food supply chain require, for example, higher quality and cheaper food products and food traceability, which in turn leads to agricultural intensification, supply chain integration and increase of food miles. The underlying drivers are perceived to be, among others, the increase of consumer disposal income, the changes in demographics, the consumer increased awareness about health and food safety issues and the outbreak of food scares like BSE and salmonella.

Table 4.1. Sustainability aspects of potato supply chain.

Drivers	Pressures	State	Impacts	Responses
Primary Consumers, Retailers, Globalisation Higher quality and cheaper products, Intensive agriculture, Food traceability, Increase of storage duration, Products from all the world and all the year, Increase the value added to product, Supply chain integration Secondary Government, NGOs. Ethical trade, Environmental protection , Prudent use of natural resources, 'Keep Britain farming', Comply with stricter environmental and social legislation	Economic & Financial Costs, Business risks, Fierce competition at all stages of supply chain Environmental Emissions to air, water and soil, Energy consumption, Wastes (packaging materials, potatoes), Social Number of employees, Personnel skills and competencies	Economic & Financial Profits/ Incomes, Relationships between actors in the supply chain Environmental State of water, air, land and biosystems Social Part of employees must work in other industries, Higher personnel skills, Food quality & safety	Economic & Financial Conflicts between retailers & suppliers, packers & farmers, Buying power Environmental Ozone depletion, Global warming, More expensive energy, Ecosystem Social Rural economy	Government Packaging and waste regulation, Food standards Rural development Fresh food supply chain Environmental Audits, Food Assurance Schemes, Cleaner technologies, Supply Chain Management adoption, Source only local supplies when possible, Adoption of IT Use of environmental friendly inputs Joint British Potato Council

These drivers exert economic and financial pressures on those people and businesses engaged in supply chain, the environment and the society. Production costs are reduced, businesses have to bear greater risks and the competition among those involved in the supply chain is fiercer. The emissions to air, water and soil also increase, wastes produced increase and energy consumption goes up. Businesses also reduce the number of their employees and work force skills and competencies are improved.

The economic and financial state of those people and businesses engaged in the supply chain, and the state of the environment and the society changes because of these pressures. Some businesses' profitability is reduced, and this is also probably the case of some workers' income. Moreover, relationships between the actors of different stages in the supply chain change because partners have to work closer together. The quality of environment is worsening because the concentration of nitrates in water resources increases, CO_2 level in air goes up. Moreover, the supplies of oil and coal that produce energy reduce. Society's state also changes. While some people may be displaced possibly finding jobs elsewhere, those remaining may acquire additional skills. For their part, consumers enjoy food products of improved quality and regularity of supply.

These changes in state have economic and financial impacts on the supply chain and impacts on the environment and the society. Conflicts between the actors of the different stages in the supply chain are fiercer and more frequent than in the past because of the reduced profitability in the supply chain and the way this is allocated to each stage, even though, the supply chain is more integrated and partners work closer together. Moreover, the disposable income and consequently buying power of many participants in the supply chain is reduced, which may have impact on the well-being of the market and national economy in general. Moreover, there are negative impacts on human health and the ecosystem because of ozone depletion, global warming, and river pollution. There is also threat that future generations cannot meet their needs in energy consumption because the depletion of fossil fuel. State changes also have impacts on the society, as people get anxious because of job losses, while young people prefer not to stay and work anymore on rural areas.

The actors of supply chain respond to meditate these impacts and improve their overall performance by adopting supply chain management elements, food assurance schemes and 'greener' technologies for transportation, carrying out environmental audits and taking advantage of information technology innovations. The supply chain gets more integrated, government sets higher standards so that high quality and wholesome food products arrive to consumers and businesses engaged in the fresh food supply chain minimize any potential negative impacts on the environment and society. Government takes also measures for the development of rural areas. Moreover,

government and actors of the supply chain may also join their forces, like in the case of British Potato Council, which aims to provide help to those involved in the fresh potato supply chain to deal with the ever changing market challenges. These responses may influence drivers, pressures, state or impacts, thus making a closed system.

4.7. Summary of Chapter

This chapter dealt with the findings of the in-depth semi-structured interviews carried out to farmers, merchants, retailers and consumers. These findings are, to great extent, in line with the literature review and both of them were used to apply the DPSIR framework to the sustainability of fresh potato supply chain.

The findings from the literature review and the in-depth interviews showed that fresh potato enterprises or businesses are no longer the units in the competitive battle, but it is fresh potato supply chains which compete each other. Environmental and social issues play also an important role in the decisions management of those involved in the fresh potato supply chain nowadays, more so than 10-15 years ago. Additionally, the performance of fresh vegetables supply chain in terms of economic, environmental and social criteria, and the attitudes of participants in the supply chain about its sustainability have not been studied. Thus, it is relevant to study the sustainability of fresh vegetables supply chain using fresh potatoes as a 'case study'.

The next chapter deals with the findings from assessing the performance of fresh potato supply chain in terms of sustainability quantitative indicators. Moreover, the findings from farmers, merchants and retailers survey about their perceptions on the sustainability of their potato business during the last decade are reported. The literature review and the in-depth interviews played an important role in these surveys because they helped, among others, to identify the most relevant criteria to assess the sustainability of fresh potato supply chain.

CHAPTER 5

FARMERS' PERCEPTIONS OF SUSTAINABILITY

5.1 Introduction

This chapter deals with the findings from the survey of potato farmers. Firstly, the profile of the respondents to this survey is presented. The importance of factors which influence farmers' decision making, the influence of people or organizations on the way farmers manage their potato enterprise and the relative importance of factors limiting their enterprise performance are also reported. Afterwards, the chapter refers to farmers' self-assessment of the changes in their potato enterprise performance during the last decade. Farmers' opinions about the future of fresh potato production and the actions to be taken in the future to improve their potato enterprise are also reported. Moreover, the most important associations between farm size or sustainability actions taken by farmers, and farmers' perceptions on the sustainability of their potato enterprise are reported. Finally, the results from the conjoint analysis show the relative importance placed by farmers on economic, environmental and social performance.

5.2. Profile of the Participants in Farmers' Survey

The main criterion for the sample collection was that average annual potato area should be more than 10 hectares. This criterion was chosen after consultation with the British Potato Council in order to select those farmers that participate in the supply chain farmer-merchant-major retailer. In fact, the sample selection was successful in this respect, as 93% of the participants in the survey apply a farm assurance scheme which is a prerequisite for supplying major retailer.

According to MAFF 34% of the UK potato enterprises are bigger than 10 hectares in size and they account for around 80% of the area of potatoes. However, 80% of the participants in this survey grow more than 20 hectares of potatoes and 50% more

than 40 hectares, while 15 % and 5% of all UK farmers did so in 1999 respectively. Moreover, the respondents' mean area of potatoes was 71 hectares while the UK average is 10.6 hectares. Thus, this survey reports on the opinions of farmers of big potato enterprises (Table 5.1).

The great majority of potatoes of respondents (on average 74% of the volume) were sold to merchants/packers, while some of them were sold to the open market and even fewer directly to processors or small retailers. Very small quantities were also sold directly to consumers, seed merchants and exporters. Moreover, 73% of potatoes were supplied to fresh market, 23% for processing and 4% for seed. Taking into consideration that around 60% of potatoes produced in the UK are sold to the fresh market (i.e. retailers, fish and chips shops, and catering businesses), we can assume that bigger potato farmers are more likely to produce for the fresh market than smaller farmers, which was also confirmed in the in-depth interviews (Table 5.1).

Around half of the respondents took actions that potentially improved the environmental performance of their enterprise, such as participating in a conservation scheme, carrying out environmental audit (like LEAF) and adopting elements of precision farming technologies. Moreover, more than half of the farmers had staff development schemes in place and participated in potato growers association, which could potentially improve their farm social performance. Although, no statistics were available about the UK potato farmers' involvement in farm assurance schemes and growers associations, it is very probable that survey respondents are likely to engage such activities more than the national average (Table 5.2).

Around 70% of farmers claimed to have significantly increased investment on irrigation, grading and storage during the last decade, while 90% increased investment on harvesting systems. Although, the significant increase of investment on these sectors may be also related to increase of the area of potato enterprise, it is positive as new technologies often promise to improve farm efficiency and be more environmental friendly (Table 5.2).

Table 5.1. Descriptive statistics of farmers' profile

	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
					25	50 (Median)	75
Farm Size (Hectares)	484		12	3640	194	323	600
Average Annual Potato Area (Hectares)	70.7	503.8	8	810	25	40	80
*Proportion of Potatoes Supplied to Open Market	9.4	90.98	0	100	0	0	10
*Proportion of Potatoes Supplied to Merchants/Packers	74.1	19.17	0	100	50	90	100
*Proportion of Potatoes Supplied directly to Retailers	5.4	32.07	0	100	0	0	0
*Proportion of Potatoes Supplied to Consumers Directly	2.1	16.01	0	95	0	0	0
*Proportion of Potatoes Supplied to Processors	5.7	9.81	0	100	0	0	0
*Proportion of Potatoes Supplied to Seed Merchants	2	18.42	0	90	0	0	0
*Proportion of Potatoes Supplied to Exporters	1	10.4	0	100	0	0	0
*Proportion of Potatoes Supplied to Stock Feed	0	7.64	0	5	0	0	0
*Proportion of Potatoes Supplied to Chips Shops	0	0.33	0	10	0	0	0
*Proportion of Potatoes Supplied for Fresh	72.9	0.66	0	100	50	90	100
*Proportion of Potatoes Supplied for Processing	23.3	31.73	0	100	0	5	50
*Proportion of Potatoes Supplied for Seed	4.1	30.79	0	90	0	0	0
*Proportion of respondents							

Table 5.2. Descriptive statistics of farmers' sustainability actions

	Valid Percent		
	YES	NO	Do not know
Participation in Conservation Scheme	49.6	48.7	1.7
Carrying out Environmental Audit	49.6	50.4	
Applying Farm Assurance Scheme	93.3	6.7	
Adoption of Precision Farming Technology	45.6	51	3.3
Staff Development/Training Scheme	52.5	46.2	1.3
Participation in Potato Growers Association	56.3	43.3	0.4
Increased Investment on Irrigation	72.2	27.8	
Increased Investment on Harvesting Systems	90.3	9.3	0.4
Increased Investment on Grading	71.6	28.4	
Increased Investment on Storage	69.1	30.9	

5.3. Importance of Factors on the Sustainability of Fresh Potato Production

5.3.1. Selection of statistical tests

Non-parametric tests are used to analyse the data derived from farmers' responses because they were ordinal data collected by Likert-type scale. Friedman test is used to find out if there is significant difference among the means of the selected factors and their relative importance is also ranked. Wilcoxon Signed Ranks Test shows if there is a significant difference (increase or decrease) in the importance of factors between 1990 and 2000. Moreover, Descriptive statistics, such as mean, median, mode and standard deviation and Frequencies statistics (valid percent) were also found useful to show the relative importance of factors associated with the sustainability of the potato enterprise. Mean and standard deviation are theoretically statistically meaningful only for data measured at interval or ratio scale, which is not the case for these questions (Field, 2000). However, such statistics were found useful to indicate the differences in the importance of factors and thus they were used with caution.

5.3.2. Importance of selected factors on farmers' decision making

All factors were perceived by farmers to be relevant in their management decisions for their potato enterprise in 2000, but some were more influential than the

others (Table 5.3). The Friedman test showed that profitability (mode=5) was the most important factor in farmers' management decisions for their potato enterprise in 2000, followed by a group of market related factors (market requirements, relationships with the supply chain and food product safety and quality) and land and soil quality, which were regarded also as very important (mode=4 or 5) (Table 5.4). Moreover, environmental and social related factors (personnel management, water for irrigation, climate and use of new technologies) and business uncertainty were rather important (mode=4). By comparison, environmental risk and community and local interests (mode=3) were moderately important for farmers' decision making. Thus, financial and market related factors were perceived to be considerably more important to farmers' management decisions than environmental and social ones in 2000.

Table 5.3. Relative importance of factors influencing farmer decisions on potato enterprise management

Ranks based on Friedman Test				
	1990 Mean Rank	2000 Mean Rank	1990 Rank	2000 Rank
Profitability	10.74	10.15	1	1
Climate	6.58	5.6	5	9
Land and Soil Quality	8.27	7.7	2	4
Water for Irrigation	6.22	6.08	8	7
Environmental Risk	3.69	4.45	12	11
Personnel Management	6.57	6.1	6	6
Relationships with SC	6.38	7.88	7	3
Business Uncertainty	5.51	5.95	9	8
Market Requirements	6.94	8.39	4	2
Food Product Safety and Quality	5.51	7.12	9	5
Community and Local Interests	3.91	3.06	11	12
Use of New Technologies	7.67	5.53	3	10

Test Statistics[a]		
	1990	2000
N	224	229
Chi-Square	831.779	861.31
df	11	11
Asymp. Sig.	.000	.000
a Friedman Test		

Table 5.4. Descriptive Statistics of the importance of factors influencing farmer decisions on potato enterprise management

	Mode	Median	Mean	Std. Deviation
2000 Profitability	5	5	4.85	0.37
2000 Climate	4	4	3.65	0.86
2000 Land and Soil Quality	4	4	4.24	0.63
2000 Water for Irrigation	5	4	3.6	1.3
2000 Environmental Risk	3	3	3.35	0.91
2000 Personnel Management	4	4	3.8	0.94
2000 Relationships with SC	4	4	4.25	0.73
2000 Business Uncertainty	4	4	3.79	0.87
2000 Market Requirements	5	4	4.42	0.6
2000 Food Product Safety and Quality	4	4	4.09	0.78
2000 Community and Local Interests	3	3	2.88	0.99
2000 Use of New Technologies	4	4	3.72	0.77
1990 Profitability	5	5	4.47	0.67
1990 Climate	3	3	3.18	1.01
1990 Land and Soil Quality	4	4	3.64	0.8
1990 Water for Irrigation	3	3	2.97	1.3
1990 Environmental Risk	2	2	2.39	0.87
1990 Personnel Management	3	3	3.18	0.92
1990 Relationships with SC	3	3	3.16	0.94
1990 Business Uncertainty	3	3	2.83	0.89
1990 Market Requirements	3	3	3.28	0.87
1990 Food Product and Quality	3	3	2.87	0.94
1990 Community and Local Interests	3	2	2.43	1.01
1990 Use of New Technologies	3	3	3.45	0.75

There was also a significant difference between the relative importance of the selected factors in farmers' management decisions for their potato enterprise in 1990 (Table 5.3). Profitability (mode=5) was by far the most important factor in farmers' management decisions for their potato enterprise in 1990, followed by land and soil quality (mode=4). Most of the other factors were moderately important (mode=3) while community and local interests and environmental risk (mode=3) were regarded as, in 2000, as the relatively least important for farmers' decision making. Hence, it seems that potato farming was mainly profitability driven in 1990 and the rest of the factors were almost equally important to farmers.

Friedman test on the importance of selected factors, on farmers' decision making, showed that profitability was the most important factor in both 1990 and 2000, while land and soil quality and market requirements were the next most relatively important factors (Table 5.3). Relationships with the supply chain, and food product safety and quality gained a lot of relative importance during 1990-2000. Moreover, personnel management, water for irrigation and business uncertainty remained relatively important. Use of new technologies and climate became relatively less important during 1990-2000. Both environmental risk and community and local interests were the relatively least important factors throughout the period.

Wilcoxon Signed Ranks test showed that all the selected variables were significantly more important in farmers' decision making for their potato enterprise in 2000 than they used to be in 1990 (Table 5.5). However, there was some variation in the increase of importance (Z value of Wilcoxon Signed Ranks Test) of the selected variables during 1990-2000. Higher Z values indicated greater increase of importance.

Table 5.5. Changes in the relative importance of factors influencing farmer decisions on potato enterprise management

	$Z^{(w)}$
1990 Profitability - 2000 Profitability	-8.374(a) (**)
1990 Climate - 2000 Climate	-8.329(a) (**)
1990 Land and Soil Quality - 2000 Land and Soil Quality	-9.569(a) (**)
1990 Water for Irrigation - 2000 Water for Irrigation	-7.919(a) (**)
1990 Environmental Risk - 2000 Environmental Risk	-11.369(a) (**)
1990 Personnel Management - 2000 Personnel Management	-9.282(a) (**)
1990 Relationships with SC - 2000 Relationships with SC	-11.446(a) (**)
1990 Business Uncertainty - 2000 Business Uncertainty	-10.675(a) (**)
1990 Market Requirements - 2000 Market Requirements	-11.688(a) (**)
1990 Food Product and Quality - 2000 Food Product Safety and Quality	-11.947(a) (**)
1990 Community and Local Interests - 2000 Community and Local Interests	-7.700(a) (**)
1990 Use of New Technologies - 2000 Use of New Technologies	-5.334(a) (**)
[w]. Wilcoxon Signed Ranks Test	
a Based on positive ranks. The 2000 mean value is higher than 1990 mean value.	
** Difference of means is significant at the .01 level (2-tailed).	

Profitability became a more dominant factor, even though it was very important in 1990. Community and local interests and use of new technologies showed a relatively moderate upward shift in their importance during 1990-2000. Moreover, climate, land and soil quality, water for irrigation and personnel management increased their importance in farmers' decision making rather significantly. Finally, relationships with the supply chain, business uncertainty, market requirements, food product safety and quality and environmental risk became much more important in farmers' decision management in 2000 than they used to be in 1990. Thus, financial and market related factors gained far more importance during the last decade than environmental and social, possibly because of the increased competition in farming industry.

Frequencies and descriptive statistics showed that on average the variability of farmers' answers on factors importance for both 1990 and 2000 was similar, but there was more convergence in the responses for profitability, relationships with the supply chain and market requirements in 2000 than in 1990. Moreover, there was considerably greater variation of answers for water for irrigation than of other factors (Tables 5.4).

The above analyses showed that all the selected factors were perceived to be more important, to different extents, during 1990-2000. This is judged to be attributed to the increased debate about the level of sustainability of farming and to the changes that have taken place during the last decade in the food supply chain, rather than that there were other factors that were important a decade ago and were not selected in this survey. The above mentioned reasons have heightened farmers' awareness of sustainability, raised the overall importance of the selected factors and also altered their relative ranking.

The survey confirmed that, not surprisingly, profitability has remained the key factor in farmers' decision making in the period 1990-2000. In fact, it was extremely important in 2000, indicating that farmers had to become even more financially driven in order to stay in business and face the challenges arising from the restructuring of the food supply chain, generally, and the potato sector, in particular. This is also evident from the great increase in the importance of financial and market related factors. For instance, market requirements, though, ranked high in 1990, became the second most important factor after profitability in 2000.

Whilst natural resources, climate and environmental factors increased considerably in perceived importance over the last decade, their relative importance to farmers' management decisions remained the same or declined during the study period. Personnel management increased its actual importance during 1990-2000 rather significantly; however, its relative importance remained the same, lower than of several other factors. Moreover, community and local interests showed moderate increase in importance between 1990 and 2000, but was among the least important factors.

On average the variability of farmers' answers on factors importance for both 1990 and 2000 was rather similar, but there was more convergence in the responses for profitability, relationships with the supply chain and market requirements in 2000 than in 1990. This may be attributed to the increased debate about the financial and market related factors, which are perceived to play key role in facing the challenges of the fierce competition in the food supply chain.

The most important conclusion from farmers' answers is that their main concern is to remain in business. Profitability was and is the most (extremely) important factor in their decision making. The changes of the food supply chain resulted in increasing the importance of factors that can help farmers to better face the challenges of the new market circumstances. Environmental and social issues were perceived to be significantly more important in absolute terms in 2000 than they used to be in 1990. However, farmers, in their intense struggle to remain in business, perceive financial and market related factors to have much more relative importance in their decision making about their potato enterprise than environmental and social issues.

6.3.3. Importance of groups or organizations influence on farmers

The selected groups or organisations were found to influence, to different extents, the way farmers managed their potato enterprise in 2000 (Table 5.6). Merchants were by far the most important (median and mode=5) influence, followed by the other participants in the supply chain (consumers, retailers and farm advisor) (median=4, mode=4 or 5) (Table 5.7). Moreover, regulatory authorities, family and research institutions were the next most important influences (mode and median=3), while other

organizations (British Potato Council, conservation organisations and potato grower association) and other farmers were found to be moderately important influences. Farmers' organisation and local community were the least important influences. Hence, not surprisingly, Friedman test (Table 5.6) revealed that the market related influences had significantly the most influence, while local community was among the least important influence on farmers' decision management in 2000.

Table 5.6. Relative importance of groups or organisations influencing farmer decisions on potato enterprise management

Ranks based on Friedman Test				
	1990 Mean Rank	2000 Mean Rank	1990 Rank	2000 Rank
Merchants	10.38	11.47	1	1
Retailers	9.01	9.39	2	3
Consumers	8.95	9.97	3	2
Farm Advisor/Consultant	8.75	8.93	4	4
Family	7.86	6.95	5	6
Other Farmers	6.07	5.27	8	11
Local Community	4.86	4.33	12	13
Regulatory Authorities	5.81	7.13	9	5
Research Institutions	6.69	6.47	7	7
Conservation Organisation	3.82	5.55	13	9
British Potato Council	7.83	5.7	6	8
Farmer Organisations (NFU CLA)	5.61	4.47	10	12
Potato Grower Association	5.38	5.38	11	10

Test Statistics[a]		
	1990	2000
N	218	222
Chi-Square	815.392	1057.814
df	12	12
Asymp. Sig.	.000	.000
a Friedman Test		

The Friedman test showed that there is significant difference in the influence of people or organisations on the way farmers managed their potato enterprise in 1990 (Table 5.6). Merchants (mode and median=4) were the most important influence, while

the other participants in the supply chain (consumers, retailers and farm advisor) (median and mode=3) were the next most important influences (Table 5.7). Family and British Potato Council (mode and median=3) were moderately important, followed by research institutions (mode and median=3) and other farmers (mode and median=2). Moreover, regulatory authorities, farmers' organisation, potato grower association, and local community (mode=2 or 1 and median=2) were the next important influences, and conservation organisation was the least (mode=1; median=2) important influence. Thus, the market related influences dominated on farmers decision making in 1990.

Table 5.7. Descriptive Statistics of the importance of groups or organisations influencing farmer decisions on potato enterprise management

	Median	Mode	Mean	Std. Deviation
2000 Merchants	5	5	4.51	0.62
2000 Retailers	4	5	3.79	1.24
2000 Consumers	4	4	3.95	1.03
2000 Farm Advisor/Consultant	4	4	3.62	0.98
2000 Family	3	3	3.03	1.2
2000 Other Farmers	3	3	2.53	0.93
2000 Local Community	2	2	2.26	1.04
2000 Regulatory Authorities	3	3	3.08	1.03
2000 Academic/Research Institutions	3	3	2.88	0.95
2000 Conservation Organisation	3	3	2.65	0.98
2000 British Potato Council	3	3	2.67	0.99
2000 Farmer Organisations	2	2	2.31	0.97
2000 Potato Grower Association	3	3	2.52	1.17
1990 Merchants	4	4	3.64	0.93
1990 Retailers	3	3	3.16	1.08
1990 Consumers	3	3	3.16	0.96
1990 Farm Advisor/Consultant	3	3	3.08	1.11
1990 Family	3	3	2.77	1.18
1990 Other Farmers	2	2	2.31	0.9
1990 Local Community	2	1	1.98	0.95
1990 Regulatory Authorities	2	2	2.2	0.92
1990 Academic/Research Institutions	3	3	2.48	0.98
1990 Conservation Organisation	2	1	1.73	0.87
1990 British Potato Council	3	3	2.78	1.03
1990 Farmer Organisations	2	2	2.17	1.01
1990 Potato Grower Association	2	1	2.11	1.05

Merchants were by far the most important influence on the way farmers managed their potato enterprise during the 1990-2000 period, followed by retailers, consumers and farm advisor. Consequently, market related people or organizations were the most important influences on farmers during the last decade. Family, research institutions and British Potato Council were in the middle of the ranking list of influential importance in 1990 and they remained so even in 2000, while other farmers were relatively less influential in 2000 than in 1990. On the contrary, regulatory authorities and conservation organisations gained significant relative importance between 1990 and 2000, probably because of the introduction of stricter environmental legislations and of agri-environmental schemes. Finally, farmer organisations, potato growers associations and local community changed marginally their relatively small influential role on farmers' decision making.

Wilcoxon Signed Ranks test showed that all the selected influences were significantly, to different extents, more important in farmers' decision making for their potato enterprise in 2000 than they used to be in 1990 (Table 5.8). Only exception was the influential importance of British Potato Council (former Potato Marketing Board) as no significant difference was found between the 1990 and 2000 means. Merchants, consumers, regulatory authorities and conservation organisations increased their perceived importance in influencing farmers' decision making, probably because of the reorganisation of the food supply chain and the requirements to better protect the environment and to use natural resources more efficiently.

Moreover, frequencies and descriptive statistics showed that on average the variability of answers on influences importance for both 1990 and 2000 was similar, but there was more convergence in the responses for merchants in 2000 than in 1990 (Table 5.7). Moreover, the variation of answers for all influences for both 1990 and 2000 did not differ significantly.

The key conclusion is that farmers perceive that all selected groups or organisations, as identified in the informal interviews, increased the importance of their influence, to different extents, during 1990-2000, except for the British Potato Council. This could be attributed, of mentioned before, to the increased debate about the sustainability at agriculture and to the fundamental changes that took place during the

last decade in the food supply chain. Thus, the players from all the stages of the supply chain (farmers, merchants and retailers) had come closer together to face the challenges of the new era and better satisfy the market needs. Moreover, farmers realised, in the meantime, that they have more need of the consultation and advice of groups or organisations such as farm consultant, family, colleagues, academic/ research institutions, local community, potato growers association, farmer and conservation organisations. Moreover, although the potato production has become more deregulated in the last 10 years, government and regulatory authorities increased their influence mainly due to the introduction of environmental, social and food safety legislation.

Table 5.8. Changes in the relative importance of groups or organisations influencing farmer decisions on potato enterprise management

	$Z^{(w)}$
1990 Merchants - 2000 Merchants	-10.551(a) (**)
1990 Retailers - 2000 Retailers	-7.223(a) (**)
1990 Consumers - 2000 Consumers	-8.927(a) (**)
1990 Farm Advisor/Consultant - 2000 Farm Advisor/Consultant	-7.191(a) (**)
1990 Family - 2000 Family	-5.205(a) (**)
1990 Other Farmers - 2000 Other Farmers	-4.358(a) (**)
1990 Local Community - 2000 Local Community	-5.572(a) (**)
1990 Regulatory Authorities – 2000 Regulatory Authorities	-10.664(a) (**)
1990 Academic/Research Institutions - 2000 Academic/Research Institutions	-7.039(a) (**)
1990 Conservation Organisation - 2000 Conservation Organisation	-10.818(a) (**)
1990 British Potato Council - 2000 British Potato Council	-1.585(b)
1990 Farmer Organisations NFU CLA - 2000 Farmer Organisations NFU CLA	-3.569(a) (**)
1990 Potato Grower Association - 2000 Potato Grower Association	-6.971(a) (**)
[w]. Wilcoxon Signed Ranks Test	
a Based on positive ranks. The 2000 mean value is higher than 1990 mean value.	
b Based on negative ranks. The 1990 mean value is higher than 2000 mean value.	
** Difference of means is significant at the .01 level (2-tailed).	

Merchants were the most important influence on the way farmers managed their farm in both 1990 and 2000. This influence strengthened during the last decade reflecting the changes in the structure of the food supply chain. This finding is not

surprising taking into consideration that during the in-depth interviews farmers emphasised their closer relationship with merchants during the last decade as well as their need to come closer with all the participants of the supply chain. Once more, it becomes evident that farmers' main concern is to stay in business and since their bargaining power against merchants and retailers has weakened significantly after the restructure of the food supply chain they have to take into consideration merchant and retailer requirements much more that they used to do. Thus, the role of the independent farm advisor is becoming more important guiding farmers to face better the new challenges of potato production.

Rather interestingly, potato grower associations, farmer organisations and other farmers seem to be among the least important influences for farmers in both 1990 and 2000, although there has been relatively moderate or marginal increase in importance during 1990-2000, indicating probably a lack of trust or co-operation between farmers. This finding could prove rather important for those that argue that co-operatives could be the answer for farmers to increase their bargaining power against merchants and retailers. However, farmers report that they still take into account the opinion of their family, indicating that farming still retains, maybe to lesser extent, characteristic of a family business.

British Potato Council has retained influence on farmers to a moderate extent, and its transformation (the Potato Marketing Board was reshaped in 1997 changing its activities and responsibilities and renamed to BPC) changed its role from intervention to indirect support and facilitation. It is apparent that the majority of the decisions affecting the fresh potato supply chain are the outcome of negotiations between merchants and retailers with the latter having more negotiating power. The role of BPC is intentionally reduced in this respect, but farmers still perceive its relevance as facilitating institution. Research institutions were also a moderate influence and gained a moderate increase in importance during the last decade. However, academic and research community were perceived to play a more important role than farmers organisations.

Conservation organisations were not among the most important influences on farmers, however, their importance increased significantly during this period. This

agrees with the findings from the analysis of selected factors importance on farmers' management decisions (questions 1 and 2) where it was showed that environmental related issues have become much more important. This is probably due to environmental, social and food safety legislation, which also explains the significant increase of the influence of regulatory authorities, despite the deregulation of potato production itself in 1997. Finally, local community only influenced farmers a little, showing a marginal increase between 1990 and 2000. This was also evident in the findings from the analysis of selected factors importance on farmers' management decisions (questions 1 and 2) and from farmers' perceptions in the in-depth interviews, who mentioned that their farming practices usually have little impact on the local society.

On average the variability of farmers' assessment of influences for both 1990 and 2000 was rather similar, but there was more convergence in the responses for merchants in 2000 than in 1990. This may be attributed to the increasingly closer relationships between farmers and merchants during the last decade.

Farmers' main influences during the last decade were groups or organisations directly involved in the food supply chain and predominantly merchants, retailers and consumers. However, government and regulatory authorities influenced considerably farmers' decision making in the last decade and more interestingly they have increased significantly their importance. Moreover, it was found that farmers own community was the least important influence, while other groups or organisations providing farmers with advice or consultancy were perceived to be a moderate influence.

6.3.4. Importance of selected factors limiting potato enterprise performance

The Friedman test showed that there is a significant difference in the perceived importance of selected factors limiting or constraining the performance of farmers' potato enterprise in 2000 (Table 5.9). Variability of potato price (mode=5) was the most important limiting factor (Table 5.10), while land and soil quality and variability of potato quality (mode=4) were the next most limiting. Relationships with packers,

climate, financial resources, water for irrigation and variability of potato quantity (mode=3 or 4) were the next most limiting. Moreover, relationships with retailers, quality of labour force and information about market needs (mode=3 or 2) had a moderate limiting impact, while availability of technology and availability of advice and technical expertise (mode= 2) were the least limiting factors in 2000. Not surprisingly, farmers perceive as the most limiting factors on the performance of potato enterprise to be those that directly influence profits such as variability of potato price, variability of potato quality and land and soil quality as it affects productivity.

Table 5.9. Relative importance of factors limiting the performance of farm potato enterprise

Ranks based on Friedman Test				
	1990 Mean Rank	2000 Mean Rank	1990 Rank	2000 Rank
Quality of Labour Force	6.15	5.64	10	10
Land and Soil Quality	8.14	9.01	2	3
Water for Irrigation	6.69	7.04	7	7
Climate	6.78	7.44	6	5
Relationships with Merchants	7.02	7.68	5	4
Relationships with Retailers	5.98	5.9	12	9
Information about Market Needs	5.73	5.56	13	11
Financial Resources	6.68	7.3	8	6
Variability of Potato Quality	8.14	9.04	3	2
Variability of Potato Quantity	7.85	6.88	4	8
Variability of Potato Price	9.5	9.96	1	1
Availability of Advice and Technical Expertise	6.04	4.62	11	13
Availability of Technology	6.3	4.91	9	12

Test Statistics[a]		
	1990	2000
N	215	225
Chi-Square	270.554	605.747
df	12	12
Asymp. Sig.	.000	.000
a Friedman Test		

Table 5.10. Descriptive Statistics of the importance of factors limiting the performance of farm potato enterprise

	Mode	Median	Mean	Std. Deviation
2000 Quality of Labour Force	2	3	2.99	1.25
2000 Land and Soil Quality	4	4	3.85	0.96
2000 Water for Irrigation	4	4	3.34	1.27
2000 Climate	3	3	3.47	0.94
2000 Relationships with Merchants	4	4	3.55	1.12
2000 Relationships with Retailers	3	3	3.04	1.23
2000 Information about Market Needs	2	3	3.01	1.05
2000 Financial Resources	4	4	3.42	1.24
2000 Variability of Potato Quality	4	4	3.88	0.97
2000 Variability of Potato Quantity	3	3	3.32	0.99
2000 Variability of Potato Price	5	4	4.14	0.91
2000 Availability of Advice and Technical Expertise	2	3	2.78	1.11
2000 Availability of Technology	2(a)	3	2.87	1.04
1990 Quality of Labour Force	2	3	2.73	1.03
1990 Land and Soil Quality	3	3	3.25	0.98
1990 Water for Irrigation	3	3	2.89	1.27
1990 Climate	3	3	2.9	1.04
1990 Relationships with Merchants	3	3	2.93	0.97
1990 Relationships with Retailers	2	3	2.64	1.01
1990 Information about Market Needs	2	3	2.59	0.96
1990 Financial Resources	3	3	2.87	1.14
1990 Variability of Potato Quality	3	3	3.21	0.88
1990 Variability of Potato Quantity	3	3	3.13	0.92
1990 Variability of Potato Price	4	4	3.6	1.02
1990 Availability of Advice and Technical Expertise	3	3	2.68	0.89
1990 Availability of Technology	3	3	2.76	0.93

a. Multiple modes exist. The smallest value is shown

Table 5.9 also shows that the selected factors were perceived to limit, to different extent, the performance of farmers' potato enterprise in 1990. Variability of potato price (mode=4) was the most important constraining factor, followed by land and soil quality, variability of potato quality and variability of potato quantity (mode=3) (Table 5.10). Relationships with packers, climate, water for irrigation and financial resources (mode=3) were the next most limiting factors. Availability of technology, quality of labour force, availability of advice and technical expertise, relationships with

retailers and information about market needs (mode=3 or 2) were the least limiting factors. Hence, factors directly influencing enterprise profitability were found to be the most limiting in 1990, as in 2000, while all the other factors were almost equally moderately limiting.

The Friedman test revealed that variability of potato price was the most important factor limiting or constraining the performance of farmers' potato enterprise in both 1990 and 2000, followed by land and soil quality and variability of potato quality (Table 5.9). Variability in potato quantity were perceived to be relatively less as a constraint in 2000 compared in 1990, but access to financial resources were perceived to have increased relatively as a constraint on the potato enterprise. This probably implies that farmers managed to achieve more stable volumes of crop during the last decade.

All factors were significantly more limiting in farmers' potato enterprise performance in 2000 than they used to be in 1990 with only exceptions availability of advice and technical expertise and availability of technology (Table 5.11). Farmers probably perceive all these factors to be more limiting nowadays than 10 years ago because of the increasing commercial pressures in what has become a less regulated, more market oriented sector. This is consistent with the in-depth interviews which revealed that farmers need to be more efficient than a decade ago and they have closer links to the other participants of the supply chain.

Frequencies and descriptive statistics showed that on average the variability of answers on factors importance for both 1990 and 2000 was similar, but there was more convergence in responses for quality of labour force, availability of advice and relationships with retailers in 1990 than in 2000 (Tables 5.10).

The farmer survey confirmed the findings of the in-depth interviews regarding the perceived importance of factors limiting potato enterprise performance during 1990-2000. Variability of potato price was the most important factor perceived to limit or constraining the performance of farmers' potato enterprise in both 1990 (mode=4) and 2000 (mode=5). This can be attributed to the fact that potato prices vary a lot from year

to year due to variation in harvest supply and consequently such variation may influence significantly the profit levels.

Table 5.11. Changes in the relative importance of factors limiting the performance of farm potato enterprise

	$Z^{(w)}$
1990 Quality of Labour Force - 2000 Quality of Labour Force	-3.269(a) (**)
1990 Land and Soil Quality - 2000 Land and Soil Quality	-7.981(a) (**)
1990 Water for Irrigation - 2000 Water for Irrigation	-4.585(a) (**)
1990 Climate - 2000 Climate	-7.496(a) (**)
1990 Relationships with Merchants - 2000 Relationships with Merchants	-7.104(a) (**)
1990 Relationships with Retailers - 2000 Relationships with Retailers	-4.892(a) (**)
1990 Information about Market Needs - 2000 Information about Market Needs	-5.778(a) (**)
1990 Financial Resources - 2000 Financial Resources	-6.569(a) (**)
1990 Variability of Potato Quality - 2000 Variability of Potato Quality	-7.973(a) (**)
1990 Variability of Potato Quantity - 2000 Variability of Potato Quantity	-2.806(a) (**)
1990 Variability of Potato Price - 2000 Variability of Potato Price	-7.519(a) (**)
1990 Availability of Advice and Technical Expertise – 2000 Availability of Advice and Technical Expertise	-1.642(a)
1990 Availability of Technology - 2000 Availability of Technology	-1.640(a)
[w]. Wilcoxon Signed Ranks Test	
a Based on positive ranks. The 2000 mean value is higher than 1990 mean value	
** Correlation is significant at the .01 level (2-tailed).	

Land and soil quality and variability of potato quality were the next most limiting factors in 1990 (mode=3) as well as in 2000 (mode=4), but they were considerably more limiting in 2000 than in 1990. This is due to the strong relationship between the land and soil quality and the fresh potato quality produced, and between the quality and price achieved. Moreover, the relative stability of average potato yield per hectare over the last decade (for the whole sector) explains why the variability of potato quantity (mode=3) has only slightly increased its moderate importance as limiting factor between 1990 and 2000.

Relationships with merchants were perceived to be more limiting than relationships with retailers during 1990-2000 due to the closer relationship between farmers and packers. The moderate increase of both factors between 1990 and 2000 shows that farmers expect that improved relationships with merchants and retailers could help them face the market challenges. However, it has to be mentioned again that the respondents of this survey were among the biggest potato producers, which can probably explain the fact that relationships with the rest of the supply chain were not considered as major limiting factors.

Information about market needs was moderately limiting in 2000, showing a moderate increase since 1990. This indicates that, although, the participants in the food supply chain are presently better informed about consumer preferences than they used to be 10 years ago, farmers still think that they can benefit from having better access to marketing data such as market segmentations and opportunities for sophisticated-niche products. Moreover, financial resources increased their importance in the last decade considerably, which is another indication that farmers have experienced commercial pressures over the last decade.

Environmental related factors like water for irrigation and climate have also become more limiting to potato enterprises performance during 1990-2000 (Table 5.11) because of the increasing importance of producing higher quality potatoes and as early as possible achieving in this way higher prices and better satisfying packers and retailers requirements.

Quality of labour force was slightly more limiting in 2000 (mode=2) than in 1990 (mode=2). This is probably because farmers may believe that increasing the qualifications of the labour employed in agriculture could somehow help them to improve the performance of their potato enterprise. Finally, availability of advice and technical expertise and availability of technology were among the least (mode=2 or 3) limiting factors in both 1990 and 2000, but their moderate values may imply that farmers perceive that better access to advice, technical expertise and technology could benefit their potato enterprise.

Results show that profitability is the key performance indicator and constraints on performance are those which are perceived to limit profitability. Relationships with the rest of the supply chain, environmental and social related factors became more limiting in the performance during 1990-2000, indicating that special effort should be made to overcome these obstacles. Thus, it is becoming obvious once more that farmers, in their efforts to remain in business, seem that they perceive financial and market related factors to limit more their enterprise performance than environmental and social related factors.

5.4. Farmers' Self-Assessment on the Changes of the Performance of their Potato Enterprise during 1990 and 2000

5.4.1. Selection of statistics

The data obtained by this question are non-parametric, as a 7-point Likert scale was used. Descriptive statistics, like mean, median, mode, standard deviation, minimum, maximum and percentiles (25, 50 (median) and 75) were found useful to analyse the responses of farmers to this question (Table 5.13). Moreover, Frequencies statistics (Valid Percent) were used to better understand the way farmers answered each question (Table 5.12). Mean and standard deviation, as mentioned before, were found useful in this research to interpret answers and thus, they were used with caution.

5.4.2. Discussion on farmers' self-assessment and opinions on the trade-offs between sustainability elements

Potato farmers reported that on average they were less satisfied with their business (mode=4) than they used to be 10 years ago. Although, there was significant dispersion of answers, the majority of them were concentrated on neutral and negative points. This lack of satisfaction is probably mainly attributed to farmers' belief that the profitability (mode=4, median=3) of their business has decreased during the last 10 years. Some (23%) reported that they agree that profitability has improved, but most of

Table 5.12. Frequencies Statistics (Valid Percent) of farmers' self-assessment on the changes of the performance of their potato enterprise during 1990 and 2000 and opinions on the trade-offs between sustainability elements

	Totally Disagree	Mostly Disagree	Slightly Disagree	Neither Agree Nor Disagree	Slightly Agree	Mostly Agree	Totally Agree
Output Per Worker Increased	0	0.8	2.1	3.3	10	26.8	56.9
Relationships with Merchants Improved	0.8	2.5	6.8	11.4	14.8	40.9	22.8
Relationships with Retailer Improved	2.1	4.3	8.1	32.5	21.4	20.5	11.1
Relationships with Employees Improved	0.4	0.4	1.3	26.5	18.5	36.1	16.8
Relationships with Local Community Improved	0.4	3.4	11.3	43.7	20.2	19.3	1.7
Potatoes are of Higher Quality	0	0.8	2.5	7.1	16.7	41	31.8
Knowledge of Market Needs Improved	0	0	0.4	3.3	16.7	49.6	30
Being Producer More Satisfying	17.6	12.6	14.6	27.6	13	12.6	2.1
Use of IT Increased	1.3	0.8	1.7	9.2	23.9	38.2	24.8
Overall Profitability Improved	14	17.8	21.6	22.9	11.9	11	0.8
Land & Soil Management Improved	0.4	0	3.3	9.6	23.8	38.9	23.8
Irrigation Management Improved	2.6	0	1.3	22.2	19.6	27	27.4
Environmental Pollution Risk Reduced	0	0.4	1.3	10.1	21	39.5	27.7
Employees Skills Improved	0	0.4	1.7	7.6	21.8	43.7	24.8
Reducing Environmental Risk Brings Financial Benefits	9.7	8.8	7.1	32.4	23.5	15.1	3.4
Financial Benefits Exceed Costs from Skills Improvement	0.8	1.3	1.7	17.7	29.5	30.8	18.1
Improving Skills Benefits Environment	1.3	1.7	1.3	14.2	37.9	34.5	9.1
Organic Have Environmental AND Financial Benefits	31.3	21	11.6	24	5.6	4.7	1.7
Deregulation Has Been a Good Thing	9.3	10.5	11.8	28.3	17.3	17.7	5.1

Table 5.13. Descriptive Statistics of farmers' self-assessment on the changes of the performance of their potato enterprise during 1990 and 2000 and opinions on the trade-offs between sustainability elements

	Mean	Mode	Std. Deviation	Minimum	Maximum	Percentiles		
						25	50	75
Output Per Worker Increased	6.3	7	1.02	2	7	6	7	7
Relationships with Merchants Improved	5.5	6	1.35	1	7	5	6	6
Relationships with Retailer Improved	4.7	4	1.40	1	7	4	5	6
Relationships with Employees Improved	5.4	6	1.15	1	7	4	6	6
Relationships with Local Community Improved	4.5	4	1.10	1	7	4	4	5
Potatoes are of Higher Quality	5.9	6	1.06	2	7	5	6	7
Knowledge of Market Needs Improved	6.1	6	0.80	3	7	6	6	7
Being Producer More Satisfying	3.5	4	1.68	1	7	2	4	5
Use of IT Increased	5.7	6	1.17	1	7	5	6	6.3
Overall Profitability Improved	3.4	4	1.56	1	7	2	3	4
Land & Soil Management Improved	5.7	6	1.08	1	7	5	6	6
Irrigation Management Improved	5.5	7	1.36	1	7	4	6	7
Environmental Pollution Risk Reduced	5.8	6	1.02	2	7	5	6	7
Employees Skills Improved	5.8	6	0.98	2	7	5	6	6.3
Reducing Environmental Risk Brings Financial Benefits	4.1	4	1.56	1	7	3	4	5
Financial Benefits Exceed Costs from Skills Improvement	5.4	6	1.18	1	7	5	5	6
Improving Skills Benefits Environment	5.3	5	1.10	1	7	5	5	6
Organic Have Environmental AND Financial Benefits	2.7	1	1.60	1	7	1	2	4
Deregulation Has Been a Good Thing	4.1	4	1.65	1	7	3	4	5

them (67%) were neutral or disagreed. Thus, farmer survey confirmed the findings of the in-depth interviews that even though, potato enterprises are perceived to be more efficient than they used to be 10 years ago (employees' skills have significantly improved (mode=6, median=6) and that the output per worker (mode=7, median=7) has increased considerably), farmers perceive that profit margins have been squeezed more than they would desire.

Farmers were strongly positive that the potatoes they produce are of higher quality than 10 years ago (mode=6), and that their knowledge about market needs has significantly improved (mode=6). Not surprisingly, the use of Information Technology (mode=6) has also increased significantly. The survey results are in line with the preliminary findings from the literature review and the in-depth interviews, which mentioned that farmers who supply potatoes to major retailers are more aware of the market requirements than 10 years ago and the product quality has risen more than significantly.

Farmers reported that their enterprises have significantly been more environmentally benign during the last 10 years. They are rather positive about their enterprise performance change in terms of land and soil management (mode=6), and irrigation management improvement (mode=7), and environmental pollution reduction (mode=6). This was expected, since the sample of the survey consists of producers of large potato enterprises who in their great majority (93.3%) apply some farm assurance schemes, and consequently they have to manage the environmental impacts of their business.

Farmers' perceive that relationships with retailers (mode=4, median=5) and local community (mode=4) have relatively improved over the last decade, while their relationships with employees (mode=6) and merchants improved (mode=6) rather significantly. Merchants are considered to be the most important influence on the way farmers manage their potato enterprise. Thus, improvement in this relationship is a positive sign for the sustainability of the supply chain.

Farmers perceive that they have significantly improved relationships with their employees, which is a positive social indicator of sustainability. Farmers also believe

that their relationships with retailers have slightly improved, probably because of the lack of direct contact between them, even though the in-depth interviews revealed that farmers perceive that retailers play the most important role in the decision making of the supply chain. Moreover, given that farmers perceived that the local community is among the least important influences on them, it was not surprising that farmers found that they have slightly improved their relationships with local community. In general, farmers claimed that their relationships with the rest of the supply chain and the society have strengthened in a period of enormous changes in the supply chain, and thus they have improved the social capital involved in their business. This is an important message for the future of the supply chain because collaboration between all stages is crucial to face new market challenges.

Farmers expressed the view that financial benefits from improving their employees' skills exceed the associated costs (mode=6) and that improving employees skills benefits the environment (mode=5). However, they were on average neutral that reducing the risk of environmental pollution from potato production brings financial benefits (mode=4). Thus, although they believe that there is 'win-win' relationship between employees' skills (social performance indicator) and financial, as well as, environmental benefits, they are neutral about the relationship of reducing environmental pollution and financial benefits. Moreover, in principle farmers do not believe that organic potatoes could both reduce the risk of environmental pollution and bring financial benefits (mode=1, median=2) (only 12% slightly to totally agree, and 24% are neutral). Furthermore, farmers, on average, are indifferent about the benefits of the deregulation of the potato industry (mode=4), however statistical analysis presented later in this chapter revealed that there was a strong positive correlation between the size of the potato enterprise and favourable disposition to deregulation.

Farmers' self-assessment of the change in their potato enterprise performance during the last decade revealed that although production efficiency and environmental and social performance significantly improved, profitability slightly decreased and thus they drew less satisfaction from their business than 10 years ago. Moreover, although they believe that elements of social and economic performance, and social and environmental performance can simultaneously improve, they do not think that this

could be the case for environmental and economic performance. Organic production is rather unattractive to the majority of farmers, which could be an interesting topic for further research. Moreover, deregulation seems to have benefited more the producers of bigger enterprises than the smaller. These results agree with the literature review and the in-depth interviews, where it was mentioned that potato farming is perceived to be more sustainable in terms of environmental and social criteria than 10 years ago. However, farmers appear to be less satisfied, mainly because they perceive that profit margins have decreased significantly over the last decade.

5.5. Farmers' Opinions about the Future of their Potato Enterprise and Potato Production

Frequencies and descriptive statistics described in §5.4.1 are selected (Tables 5.14 and 5.15). Moreover, Friedman test ranked sustainability actions in terms of importance perceived by farmers (Table 5.16).

The most important conclusion deriving from the answers is that most farmers supported a range of proposed actions that they should get in the next decade to improve their potato enterprise sustainability. However, farmers seem to think that some actions are more important than others.

Farmers found that the most important actions to improve the sustainability of their potato enterprise are to increase cost efficiency (mode=7, median=7); increase their product quality assurance (mode=7, median=6); achieve closer relationships with other participants of supply chain (mode=6, median=6); and improve their targeting to different markets and customer requirements (mode=6, median=6). This is not surprising taking into consideration other findings of the survey, including the conjoint analysis. It is obvious that for farmers the most important concern is to stay in business in the future. Thus, it is now essential in a market oriented sector for them to focus on the needs of their customers, namely, merchants, major retailers and ultimately consumers.

Table 5.14. Frequencies Statistics (Valid Percent) of farmers' perceptions of actions to improve the sustainability of potato enterprise and likely futures of potato production

	Totally Disagree	Mostly Disagree	Slightly Disagree	Neither Agree Nor Disagree	Slightly Agree	Mostly Agree	Totally Agree
Achieve Closer Relationships with Participants of SC				2.7	10.8	43.2	43.2
Increase Quality Assurance			5.4	8.1	8.1	37.8	40.5
Increase Yields				10.8	27	40.5	21.6
Improve Targeting to Different Markets and Customer Requirements				5.4	8.1	43.2	43.2
Increase Cost Efficiency				2.8	13.9	27.8	55.6
Increase Economies of Scale or Specialisation			2.7	16.2	21.6	37.8	21.6
Improve Waste Management			5.6	22.2	25	36.1	11.1
Increase Adoption of Advanced Technology			5.4	18.9	29.7	35.1	10.8
Improve Land and Soil Management			2.8	16.7	13.9	55.6	11.1
Improve Energy Efficiency				28.6	31.4	34.3	5.7
Improve Irrigation Access and/or Efficiency		2.7	2.7	8.1	32.4	37.8	16.2
Reduce Environmental Impact	2.7	2.7	2.7	13.5	27	40.5	10.8
Demonstrate Stronger Compliance with Good Social and Environmental Practices	2.7	2.7	5.4	16.2	29.7	32.4	10.8
Improve Quality of Human Resources			5.4	8.1	45.9	24.3	16.2
Majority of Potatoes Produced under FAS				8.3	11.1	27.8	52.8
Competition in Britain from Global Sourced Potatoes More Intense			2.8	8.3	19.4	41.7	27.8
Imported Potatoes Conform Equivalent with FAS	8.3	13.9	13.9	8.3	19.4	22.2	13.9
British Potato Producers Focus on Local Market	2.8	8.3	19.4	19.4	25	22.2	2.8
Organic Fresh Potatoes More Than 10% of British Market	11.4	5.7	28.6	31.4	22.9		
Adoption of GM Potatoes Widespread	5.4	16.2	21.6	18.9	21.6	13.5	2.7

Table 5.15. Descriptive Statistics of farmers' perceptions of actions to improve the sustainability of potato enterprise and likely futures of potato production

	Mean	Mode	Std. Deviation	Minimum	Maximum	Percentiles		
						25	50	75
Achieve Closer Relationships with Participants of SC	6	6(a)		4	7	6	6	7
Increase Quality Assurance	6	7	1	3	7	6	6	7
Increase Yields	6	6	1	4	7	5	6	6
Improve Targeting to Different Markets and Customer Requirements	6	6(a)	1	4	7	6	6	7
Increase Cost Efficiency	6	7	1	4	7	6	7	7
Increase Economies of Scale or Specialisation	6	6	1	3	7	5	6	6
Improve Waste Management	5	6	1	3	7	4	5	6
Increase Adoption of Advanced Technology	5	6	1	3	7	5	5	6
Improve Land and Soil Management	6	6	1	3	7	5	6	6
Improve Energy Efficiency	5	6	1	4	7	4	5	6
Improve Irrigation Access and/or Efficiency	5	6	1	2	7	5	6	6
Reduce Environmental Impact	5	6	1	1	7	5	6	6
Demonstrate Stronger Compliance with Good Social and Environmental Practices	5	6	1	1	7	4	5	6
Improve Quality of Human Resources	5	5	1	3	7	5	5	6
Majority of Potatoes Produced under FAS	6	7	1	4	7	6	7	7
Competition in Britain from Global Sourced Potatoes More Intense	6	6	1	3	7	5	6	7
Imported Potatoes Conform Equivalent with FAS	4	6	1	1	7	3	5	6
British Potato Producers Focus on Local Market	4	5	2	1	7	3	4.5	6
Organic Fresh Potatoes More Than 10% of British Market	3	4	1	1	5	3	4	4
Adoption of GM Potatoes Widespread	4	3(a)	1	1	7	3	4	5

a Multiple modes exist. The smallest value is shown

Table 5.16. Relative importance of actions to improve sustainability of farm potato enterprise in the next decade

Ranks based on Friedman Test	
	Mean Rank
Increase Cost Efficiency	10.61
Improve Targeting to Different Markets and Customer Requirements	10.08
Achieve Closer Relationships with Participants of SC	9.86
Increase Quality Assurance	9.36
Increase Economies of Scale or Specialisation	7.77
Increase Yields	7.42
Improve Land and Soil Management	7.39
Improve Irrigation Access and/or Efficiency	6.92
Reduce Environmental Impact	6.34
Improve Quality of Human Resources	6.31
Increase Adoption of Advanced Technology	5.88
Demonstrate Stronger Compliance with Good Social and Environmental Practices	5.8
Improve Waste Management	5.7
Improve Energy Efficiency	5.56

Test Statistics(a)	
N	32
Chi-Square	93.308
df	13
Asymp. Sig.	0
a Friedman Test	

Farmers' concern to stay in business is also explicit from the fact that they agree, to great extent, that they have to increase economies of scale or specialisation (mode=6, median=6); increase yields (mode=6, median=6); improve land and soil management (mode=6, median=6); and improve irrigation access and/or efficiency (mode=6, median=6). Land and soil management is becoming increasingly important as there are, and will be in the future, stricter restrictions in terms of the chemical inputs used to increase the fertility of soil, and thus the yields achieved. Moreover, water resources are becoming more limited and the price of water for irrigation is likely to increase. The UK Government and the European Union are concerned about the availability of water resources and attempt with measures to encourage businesses to use water in a more

prudent way. For example, the EU Water Framework Directive refers to tradeable permits for water abstractions.

Actions targeting to improve the environmental and social performance of potato enterprises, such as reduction of environmental impact (mode=6, median=6); improvement of quality of human resources (mode=5, median=5); increased adoption of advanced technology (mode=6, median=5); demonstration of stronger compliance with good social and environmental practices (mode=6, median=5); improvement of waste management (mode=6, median=5); and improvement of energy efficiency (mode=6, median=5) are not on the top of farmers' list of actions to carry out, however, very few farmers disagree that they should promote them in future. This can be explained, inter alia, from farmers' strong belief that the majority of potatoes in the UK will be produced under Farm Assurance Schemes (mode=7, median=7). Moreover, farmers are aware that in future they may need to show stronger compliance with good social and environmental practices.

Farmers also agree that they will face more intense competition from global sourced potatoes in the next decade (mode=6, median=6). However, they slightly agree that the imported potatoes will conform to the equivalent of their own Farm Assurance Schemes they apply (mode=6, median=5). Farmers, on average, slightly agree that British potato producers will focus on local market (mode=5, median=4.5). Moreover, farmers slightly disagree that organic fresh potatoes will account for more that 10% of British market (mode=4, median=4) and that the adoption of Genetically Modified potatoes will be widespread in ten years (mode=4, median=3). However, it should be mentioned that there was a great in views on these issues regarding the future of fresh potato production.

Farmers believe that they will face stronger competition in future because of globalisation of food markets. However, they also think that the majority of British potatoes will be produced under farm assurance schemes. Thus farmers feel that apart from taking those actions that could secure satisfactory profitability for their enterprise, they have also to improve their environmental and social performance. Moreover, it seems that farmers feel that they are in less favourable position than their competitors from abroad, as a lot of them believe that the imported potatoes will not conform to the

equivalent to British farm assurance schemes. Finally, there is a great variation of farmers beliefs for the future of organic and GM food products. This might reflect current knowledge or understanding, that they are not very well informed about these issues, that there are various and potentially contradictory sources of information on these topics, or that there is a lot of uncertainty about the future of organics and GMOs. It is apparent that there is some resistance to organics possibly because of difficulties to convert whole farm to organic, changes in management implied, and the commercial risks and uncertainties involved.

5.6. Sustainability Actions Association with Farmer Perceptions of their Potato Enterprise Sustainability

5.6.1. Introduction

Profile and sustainability activities related questions of farmer survey had a two-fold aim; on the one hand, to get a profile of the participants of the survey and on the other hand to find out if there is association between farm profile or selected sustainable actions, and the farmers perceptions about the factors that influence their decision making, the performance of their enterprise and future actions for performance improvement. The profile and the sustainability actions taken of the respondents were presented in the beginning of this chapter. This part of the analysis deals with the second issue.

5.6.2. Selection of statistical tests

Non-parametric tests were used to analyse the data derived from farmers' responses because they were collected by Likert-type scale. Mann-Whitney test was used for identifying potential differences in the means of respondents' classes of a selected sustainability action such as, for example, farmers who participated or did not participate in a growers' association. The significant value of the test, which gives the

two-tailed probability that the magnitude of the test statistic is a chance result, was mostly considered at the interpretation of the results (Field, 2000).

Moreover, Kendall's tau b test was used to measure the correlation between variables. Although, Spearman's statistic is more popular than Kendall's tau b, Field (2000) mentions that Kendall's statistic is a better estimate of the correlation in the population. Moreover, in the first steps of the analysis, both tests were used but it was found that there were not any significant differences in the results. Finally, although almost all possible associations between variables were examined, the tables include only the cases where significant association was found.

5.6.3. Average annual area of potatoes

The average annual area of potatoes was examined for any potential associations with farmer perceptions of their potato enterprise sustainability. The median of potato enterprise size derived from the responses was 40 hectares. The respondents were split in 2 groups, the lower 50% those with 40 hectares or less, and the higher (upper) 50% those with more than 40 hectares.

The size of potato enterprise was associated with farmers' perceptions of some aspects of their potato enterprise sustainability; however, the correlation coefficient in most cases was rather low (less than 0.2) (Table A.6.4, in Appendix 6). Farmers of bigger potato enterprises perceived that they have improved their relationships with merchants, their knowledge of market needs, irrigation management and employees' skills and have produced potatoes of higher quality more than smaller enterprises between 1990 and 2000 (Table 5.17). Moreover, farmers of bigger potato enterprises were considerably more favorably disposed to the deregulation in potato farming and they also claimed that they have to increase their enterprise economies of scale or specialization than smaller.

Table 5.17. Association between the size of the potato enterprise and other farmer characteristics

		Ranks [m]		Test Statistics [m]	
	POTATO AREA	N	Mean Rank	Z	Asymp. Sig. (2-tailed)
2000 Land and Soil Quality	Lower 50%	121	109.81	-2.498	0.012
	Higher 50%	117	129.52		
2000 Market Requirements	Lower 50%	121	110.36	-2.115	0.034
	Higher 50%	115	127.07		
2000 British Potato Council	Lower 50%	122	127.11	-1.967	0.049
	Higher 50%	115	110.4		
2000 Water for Irrigation	Lower 50%	122	109.99	-2.035	0.042
	Higher 50%	114	127.61		
Relationships with Merchants Improved	Lower 50%	121	107.99	-2.64	0.008
	Higher 50%	116	130.48		
Potatoes are of Higher Quality	Lower 50%	122	109.32	-2.578	0.01
	Higher 50%	117	131.13		
Knowledge of Market Needs Improved	Lower 50%	123	112.54	-1.98	0.048
	Higher 50%	117	128.87		
Irrigation Management Improved	Lower 50%	117	106.16	-2.233	0.026
	Higher 50%	113	125.17		
Employees Skills Improved	Lower 50%	121	110.88	-2.083	0.037
	Higher 50%	117	128.42		
Financial Benefits Exceed Costs from Skills Improvement	Lower 50%	120	108.77	-2.409	0.016
	Higher 50%	117	129.5		
Deregulation Has Been a Good Thing	Lower 50%	121	94.84	-5.646	0
	Higher 50%	116	144.2		
Proportion of Potatoes Supplied to Retailers	Lower 50%	117	124.09	-2.629	0.009
	Higher 50%	114	107.7		
Proportion of Potatoes Supplied to Processors	Lower 50%	117	109.37	-2.832	0.005
	Higher 50%	114	122.8		
Proportion of Potatoes Supplied for Fresh	Lower 50%	117	129.59	-3.528	0
	Higher 50%	112	99.76		
Proportion of Potatoes Supplied for Processing	Lower 50%	117	104.2	-2.68	0.007
	Higher 50%	112	126.29		
Applying Farm Assurance Scheme	Lower 50%	122	125.71	-3.013	0.003
	Higher 50%	117	114.04		
Staff Development/ Training Scheme	Lower 50%	121	132.88	-3.506	0
	Higher 50%	117	105.66		
Participation in Potato Growers Association	Lower 50%	122	135.49	-4.271	0
	Higher 50%	116	102.68		
Increased Investment on Irrigation	Lower 50%	116	130.09	-4.323	0
	Higher 50%	114	100.65		

Table 6.17 continued					
Increased Investment on Harvesting Systems	**Lower 50%**	120	125.2		
	Higher 50%	117	112.64	-2.749	0.006
Increased Investment on Grading	**Lower 50%**	117	123.6		
	Higher 50%	112	106.01	-2.572	0.01
Increased Investment on Storage	**Lower 50%**	118	132.34		
	Higher 50%	115	101.26	-4.396	0
Increase Economies of Scale or Specialisation	**Lower 50%**	18	14.47		
	Higher 50%	19	23.29	-2.579	0.01
[m]. Based on Mann-Whitney Test					

Rather surprisingly, farmers of smaller enterprises claimed to sell higher proportion of their yield directly to retailers and as fresh potatoes, while farmers of bigger enterprises sold higher proportion of yield for processing; however, the mean values between the two groups differed slightly. Moreover, farmers of smaller enterprises were more likely to claim that there is staff development/training scheme in place and participate in potato growers association than bigger, however this did not help them to report a more positive change in their performance than the bigger. Farmers of smaller enterprises also reported to have increased investment on irrigation, harvesting systems, grading, and storage, more than bigger.

5.6.4. Participation in an agri-environment or conservation scheme

There is significant positive association between farmers' participation in agri-environment or conservation schemes (e.g. Countryside Stewardship, LEAF, ESA) (50% of respondents participated) and their self-assessment of their potato enterprise change of performance in terms of environmental pollution risk reduced and employees skills improved (Table 5.18). Moreover, farmers participating in such schemes were more positive on statements like financial benefits exceed costs from skills improvement and British potato producers will focus on local market than those not participating. However, the correlation coefficients were rather low ranging between 0.123 and 0.38 (Table A.6.5).

Table 5.18. Association of participation in conservation scheme with other farmer characteristics

		Ranks [(m)]		Test Statistics [(m)]	
	Participation in Conservation Scheme	**N**	**Mean Rank**	**Z**	**Asymp. Sig. (2-tailed)**
2000 Information about Market Needs	**YES**	116	124.02	-2.038	0.042
	NO	114	106.83		
Environmental Pollution Risk Reduced	**YES**	118	130.61	-3.274	0.001
	NO	115	103.04		
Employees Skills Improved	**YES**	118	127.89	-2.65	0.008
	NO	115	105.83		
Financial Benefits Exceed Costs from Skills Improvement	**YES**	118	128.15	-2.783	0.005
	NO	114	104.44		
Improving Skills Benefits Environment	**YES**	114	125.62	-2.819	0.005
	NO	113	102.28		
British Potato Producers Focus on Local Market	**YES**	19	22.61	-2.524	0.012
	NO	17	13.91		
[m]. Based on Mann-Whitney Test					

Consequently, participation in agri-environmental scheme seems to have little influenced farmers perceptions about the sustainability of their potato enterprise only in terms of environmental and social performance.

5.6.5. Carrying out environmental audit

Environmental audit (50% of respondents participated) was positively associated with farmers' attitudes towards the importance of market requirements in their decision making and the importance of consumers on the way they managed their potato enterprise (Table 5.19). Moreover, farmers benefited from their participation in order to reduce environmental pollution risk and improve land and soil management. However, the correlation coefficient was for all answers rather low (0.120-0.167) (Table A.6.6).

Consequently, carrying out environmental audit seems to have little association with farmers perceptions for the sustainability of their potato enterprise and those

carrying out claimed to have improved few aspects of their enterprise environmental performance more than those not.

Table 5.19. Association of carrying out environmental audit with other farmer characteristics

		Ranks [m]		Test Statistics [m]	
	Carrying out Environmental Audit	N	Mean Rank	Z	Asymp. Sig. (2-tailed)
2000 Market Requirements	YES	117	127.74	-2.605	0.009
	NO	117	107.26		
2000 Consumers	YES	115	128.48	-2.449	0.014
	NO	120	107.95		
2000 Variability of Potato Quantity	YES	116	106.7	-2.32	0.02
	NO	116	126.3		
Land & Soil Management Improved	YES	118	127.56	-2.005	0.045
	NO	119	110.51		
Environmental Pollution Risk Reduced	YES	117	129	-2.46	0.014
	NO	119	108.17		
[m]. Based on Mann-Whitney Test					

5.6.6. Adoption of 'precision farming' technology

Farmers adopting elements of 'precision farming' benefited little from improving irrigation management, relationships with employees and local community and improving employees' skills (Table 5.20). Moreover, farmers adopting precision farming supported more than those not that they have to increase adoption of advanced technology in the future in order to improve enterprise performance. Hence, precision farming adoption little benefited farmers improving some aspects of their enterprise performance, however it raised farmers' awareness in increasing adoption of advanced technology in the future.

Table 5.20. Association of adoption of elements of precision farming technology with other farmer characteristics

		Ranks [m]		Test Statistics [m]	
	Adoption of Precision Farming Technology	N	Mean Rank	Z	Asymp. Sig. (2-tailed)
2000 Variability of Potato Quality	YES	106	125.17	-2.509	0.012
	NO	121	104.22		
Relationships with Employees Improved	YES	108	124.59	-2.155	0.031
	NO	121	106.44		
Relationships with Local Community Improved	YES	108	127.44	-2.83	0.005
	NO	121	103.9		
Irrigation Management Improved	YES	103	124.83	-3.1	0.002
	NO	118	98.92		
Employees Skills Improved	YES	108	125.3	-2.362	0.018
	NO	121	105.81		
Increase Adoption of Advanced Technology	YES	25	19.92	-2.46	0.014
	NO	9	10.78		
[m]. Based on Mann-Whitney Test					

5.6.7. Staff development/training programme

The adoption of staff development schemes (53% of respondents adopted) was associated with farmer perceptions of some aspects of their potato enterprise sustainability; however, the correlation coefficient in most cases was rather low (Table A.6.8). Farmers benefited to little improve their enterprise performance as they claimed higher improvement in relationships with merchants and employees, increase of Information Technology use, reduction of environmental pollution and improvement of employees skills (Table 5.21). However, such schemes did not seem to influence changes in performance in terms of increasing output per worker or improving profitability. Moreover, farmers having staff development scheme in place were more positive that skills improvement could benefit financial and environmental performance than those not. Consequently, staff development schemes little helped farmers improving some aspects of their enterprise performance, but farmers applying such schemes were more positive of employees' skills improvement in contributing to enterprise sustainability than those not.

Table 5.21. Association of existence of staff development scheme with other farmer characteristics

		Ranks [m]		Test Statistics [m]	
	Staff Development Scheme	N	Mean Rank	Z	Asymp. Sig. (2-tailed)
2000 Market Requirements	YES	124	124.7	-2.402	0.016
	NO	107	105.92		
2000 Community and Local Interests	YES	125	125.32	-1.982	0.047
	NO	109	108.53		
2000 Conservation Organisation	YES	123	124.21	-2.096	0.036
	NO	108	106.65		
Relationships with Merchants Improved	YES	124	124.96	-2.154	0.031
	NO	108	106.79		
Relationships with Employees Improved	YES	124	128.53	-2.755	0.006
	NO	110	105.07		
Use of IT Increased	YES	123	126.84	-2.468	0.014
	NO	110	106		
Environmental Pollution Risk Reduced	YES	123	126.18	-2.309	0.021
	NO	110	106.74		
Employees Skills Improved	YES	124	135.12	-4.473	0
	NO	110	97.64		
Financial Benefits Exceed Costs from Skills Improvement	YES	124	130.8	-3.45	0.001
	NO	109	101.3		
Improving Skills Benefits Environment	YES	119	123.84	-2.354	0.019
	NO	109	104.31		
Increase Economies of Scale or Specialisation	YES	23	21.09	-2.044	0.041
	NO	13	13.92		
Competition in Britain from Global Sourced Potatoes More Intense	YES	23	21.2	-2.154	0.031
	NO	13	13.73		
[m]. Based on Mann-Whitney Test					

5.6.8. Participation in growers' association or equivalent group

Farmers participating in grower's association (56% of respondents participated) were more favorably disposed to the influence of academic/research institutions, conservation organisations, British Potato Council and potato grower associations (Table 5.22). They also benefited from their participation in order to improve the knowledge of market needs, irrigation management and employees skills and were more

positive to statements like improving skills benefits environment and deregulation has been a good thing than those not. Finally, non-participating growers think that they have to improve land and soil management in the future more than participating. However, the correlation coefficients were rather low (Table A.6.9).

Consequently, participating in grower's association was associated little with farmers' perceptions for the sustainability of their potato enterprise. However, it seems that participation in growers association seems to benefit farmers on some aspects of the performance of their enterprise.

Table 5.22. Association of participation in potato growers association with other farmer characteristics

		Ranks [m]		Test Statistics [m]	
	Participation in Potato Growers Association	N	Mean Rank	Z	Asymp. Sig. (2-tailed)
2000 Water for Irrigation (Q1)	YES	134	127.76	-2.626	0.009
	NO	101	105.04		
2000 Academic/Research Institutions	YES	131	125.84	-2.261	0.024
	NO	103	106.9		
2000 Conservation Organisation	YES	130	125.17	-2.185	0.029
	NO	103	106.69		
2000 British Potato Council	YES	131	125.3	-2.084	0.037
	NO	103	107.58		
2000 Potato Grower Association	YES	128	139.94	-6.612	0
	NO	101	83.39		
2000 Availability of Technology	YES	131	123.99	-2.166	0.03
	NO	100	105.53		
Knowledge of Market Needs Improved	YES	134	127.89	-2.472	0.013
	NO	103	107.44		
Irrigation Management Improved	YES	129	127.81	-3.746	0
	NO	98	95.83		
Employees Skills Improved	YES	133	125.7	-2.103	0.035
	NO	102	107.96		
Improving Skills Benefits Environment	YES	130	123.14	-2.243	0.025
	NO	99	104.31		
Deregulation Has Been a Good Thing	YES	132	128.68	-2.929	0.003
	NO	102	103.03		
Improve Land and Soil Management	YES	23	16	-2.091	0.037
	NO	13	22.92		

[m]. Based on Mann-Whitney Test

5.6.9. Increased level of investment in irrigation

72% of respondents said that they have increased the level of investment in irrigation in the last 10 years. Farmers that claimed increased level of investment in irrigation perceived that water for irrigation (Question 1) was more important in their management decisions and more important as limiting factor in improving potato enterprise performance than those that did not increase (Table 5.23). Moreover, farmers with increased level of investment in irrigation reported higher improvement in their potato enterprise in terms of Irrigation Management (Q7) than the other farmers.

Thus, farmers with increased level of investment in irrigation seem to be more aware of water irrigation and management, but they were paid off since they reported higher improvement on their potato enterprise irrigation management than those with not increased level.

Table 5.23. Association of increased investment on irrigation and other farmer characteristics

		Ranks [m]		Test Statistics [m]	
	Increased Investment on Irrigation	N	Mean Rank	Z	Asymp. Sig. (2-tailed)
2000 Water for Irrigation (Q1)	YES	166	137.96	-9.124	.000
	NO	62	51.69		
2000 Water for Irrigation (Q5)	YES	164	119	-2.114	0.035
	NO	62	98.95		
Irrigation Management Improved	YES	166	134.11	-9.313	.000
	NO	56	44.47		
[m]. Based on Mann-Whitney Test					

5.7. Relative Importance of Economic, Environmental and Social Objectives on Farmers' Choice for Production Systems

5.7.1. Introduction

Conjoint analysis aimed to identify the relative importance of economic, environmental and social performance on the way farmers manage the fresh potato production systems.

5.7.2. Selection of statistics

The SPSS Conjoint procedure has been used to analyze the data derived from the 20 questionnaires with valid answers. Descriptive statistics, like mean, median, standard deviation, minimum, maximum and percentiles (25, 50 (median) and 75) were also found useful to better interpret the relative importance of economic, environmental and social performance. Moreover, Friedman and Wilcoxon Signed Ranks tests were used to identify if there was significant difference between the relative importance of economic, environmental and social performances. Correlations between the relative importance of performances and the answers given to the other questions of the questionnaire were also identified, using Kendall's tau b correlation test. Hierarchical Cluster and Cluster K means analyses were also carried out to find clusters of respondents with similar attitudes to the importance of economic, environmental and social performance (Field, 2000).

5.7.3. Part-worth evaluations

Part-worth evaluations (Table 5.24) are all based on the same preference score rating, hence, the total evaluation of a scenario derives from adding the part-worth evaluations of its attribute levels. Thus, scenario 1 which described a potato production system with high economic, low environmental and low social performance has a total score of:

$$(4.3722) + (1.8833) + (-1.4722) + (-1.6056) = 3.18$$

which represents the sum of part-worths of the attribute levels and the constant term. Similarly, the total evaluation of scenario 2 which describes a production system with medium economic, high environmental and high social performance is:

$$(4.3722) + (0.2333) + (0.8278) + (1.1778) = 6.61$$

Table 5.24. Averaged conjoint results for the whole farmer sample

Attribute Level	Part-worth Evaluation	Relative Importance of Attribute
Constant	**4.3722**	
Economic Performance		**42.18%**
Low	-2.1167	
Medium	0.2333	
High	1.8833	
Environmental Performance		**27.7%**
Low	-1.4722	
Medium	0.6444	
High	0.8278	
Social Performance		**30.12%**
Low	-1.6056	
Medium	0.4278	
High	1.1778	
Pearson's R		**0.968**
Kendall's tau for 2 holdouts		**1**

Thus, for the averaged results of the whole sample, scenario 2 was preferred to scenario 1. The predicted total evaluations (from the Conjoint Analysis results) should correspond closely to the actual preference scores of respondents. Table 5.25 shows that predicted preference scores are very close to the actual for scenarios 1, 2, 4, 5 and 8. However, the predicted evaluations were higher than the actual for scenarios 3 and 6, while the opposite happened with scenarios 7 and 9. This could be attributed to the small number of questionnaires (only 20), which included valid answers and could therefore be considered for conjoint analysis.

Table 5.25 Scenario predicted and actual preference scores and ranks for the whole farmer sample

Scenario	Predicted Preference Scores	Predicted Rank	Actual Preference Scores	Actual Rank
1	3.18	7	3.20	6
2	6.61	2	6.60	2
3	3.51	6	2.75	7
4	6.43	3	6.45	3
5	1.96	8	1.95	9
6	5.29	4	4.50	4
7	7.33	1	8.10	1
8	3.56	5	3.55	5
9	1.48	9	2.25	8

5.7.4. Reliability of results

Pearson's R correlation coefficient, which measures the correlation between the observed and the estimated preferences, was 0.968 for the whole sample, which is very close to 1, indicating that the model was a good fit (Table 5.24). Moreover, Pearson's R correlation coefficients for each individual respondent ranged between 0.845 and 1, showing that farmers were consistent in their preferences. Additionally, Kendall's tau statistic, which measures the correlation between the observed and predicted preferences for the hold-out scenarios (which the conjoint procedure did not use when estimating the part-worth evaluations), was 1 for the whole sample indicating as well that the model was a good fit.

5.7.5. Relative importance of the attributes

Since the part-worth evaluations are expressed on a common scale, the relative importance of each attribute can be measured. The attribute with the widest range (from low to high) of part-worth estimates is the most important attribute (Hair et al, 1992). SPSS procedure also produces the relative importance of each attribute.

Economic performance is clearly the most important criterion (42.18%, weight of the decision making) on the way farmers choose potato production systems followed by social (30.12%) and environmental (27.7%) (Table 5.24). Friedman and Wilcoxon Signed Ranks tests (Tables 5.27 and 5.28) found that for farmers economic performance is significantly more important than environmental performance. Economic performance is also more important than social. However, environmental and social performances statistically have the same importance to farmers' decision making. Moreover, descriptive statistics (Table 5.26) showed that there is a great variation in the relative importance of each performance among farmers, which can be attributed to their attitudes towards economic, environmental and social performance, and to the way they interpreted the definitions of attribute levels.

Table 5.26. Descriptive Statistics of the relative importance of attributes on farmer choice of production systems

	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						25	50	75
Importance (%) of Economic Performance	20	42.2	13.7	20.69	67.5	30.8	38.5	52.2
Importance (%) of Environmental Performance	20	27.7	8.9	4.17	46.32	22.3	28	31.9
Importance (%) of Social Performance	20	30.1	9.9	10.28	50	24.7	30.9	35.6

Table 5.27. The relative importance of attributes on farmer choice of production systems (Friedman Test)

Ranks based on Friedman Test	
	Mean Rank
Importance (%) of Economic Performance	2.45
Importance (%) of Environmental Performance	1.67
Importance (%) of Social Performance	1.88

Test Statistics(a)	
N	20
Chi-Square	6.727
df	2
Asymp. Sig.	0.035
a Friedman Test	

Apart from the relative importance of each attribute, the part-worths of attribute levels provide also useful information (Table 5.24). Thus, farmers clearly find it unacceptable that their potato enterprise achieves low economic performance (with risk of losses in some years, barely worthwhile). Moreover, even medium (acceptable and reasonable, relatively attractive enterprise) financial returns are not attractive to farmers, and they show strong preference for maximum financial return (high).

Table 5.28. The relative importance of attributes on farmer choice of production systems (Wilcoxon Signed Ranks Test)

Test Statistics(c)			
	Importance (%) of Environmental Performance - Importance (%) of Economic Performance	**Importance (%) of Social Performance - Importance (%) of Economic Performance**	**Importance (%) of Social Performance - Importance (%) of Environmental Performance**
Z	-2.464(a)	-2.112(a)	-.865(b)
Asymp. Sig. (2-tailed)	0.014	0.035	0.387
a Based on positive ranks.			
b Based on negative ranks.			
c Wilcoxon Signed Ranks test			

Farmers clearly prefer that their enterprise has not low environmental performance (little importance attached to environment, with risk of environmental damage and in some cases non-compliance with legal requirements), however, they are almost indifferent between achieving medium (generally adopt good environmental practice and comply with legal obligations) and high (very strong commitment to a high level of environmental protection and improvement, well beyond legal requirements) performance.

Low social performance is also very undesirable (little concern with business reputation in local community and risk of non-compliance with legal requirements on employment, trading practices and food safety), while high (very strong commitment to a high business reputation in the local community, actively promoting employment, trading standards and food safety standards in excess of legal requirements) is considerably preferred to medium (generally concerned to have a good business reputation in the local community, demonstrating compliance with legal requirements on employment, trading practices and food safety) performance.

Hierarchical Cluster analysis revealed that 2 main clusters exist. The k-mean cluster procedure found that Cluster 1 consists of 7 farmers whose choice on production systems is based mainly on economic performance (58%), while the relative importance of environmental is 19% and of social is 23% (Table 5.29). Cluster 2 consists of 13

farmers, who claimed that economic, environmental and social performances are equally important to them. Thus, farmers of cluster 1 are mainly financially driven and they are not that willing to compromise financial performance for environmental or social, while farmers of cluster 2 seem to believe that it is possible for economic, environmental and social performance to go 'hand by hand'.

Table 5.29. Cluster K means analysis on farmers' perceptions of the relative importance of attributes on the choice of production systems

Final Cluster Centres		
	Cluster	
	1	2
Importance (%) of Economic Performance	57.91	33.72
Importance (%) of Environmental Performance	19.08	32.33
Importance (%) of Social Performance	23.02	33.95

Number of Cases in each Cluster		
Cluster	1	7
	2	13

5.7.6. Conjoint results and farmers perception for their enterprise sustainability

Both economic and environmental performances were significantly correlated with farmers' perceptions of some aspects of their enterprise sustainability (Table 5.30). In particular, the more important the economic performance was, the more likely was for farmers to take into consideration relationships with the supply chain in their decision making and be influenced by merchants. Moreover, farmers who placed high importance in economic performance were more positive that in the next decade they have to increase the yields and the economies of scale of their enterprise. However, there was negative correlation between importance of economic performance and the importance of community and local interests in farmers' decision-making; the importance of local community influence; and the improvement of relationships with local community.

Environmental performance was correlated with the answers to the above mentioned questions in exactly the opposite way. Thus, the more important the environmental performance was for farmers, the less emphasis was given to the relationships with the supply chain in their decision making and take into consideration merchants opinions. However, environmentally sensitive farmers considered more community and local interests in their decision-making and were more influenced by local community. They placed less emphasis to increase on yields and economies of scale in order to improve the sustainability of their potato enterprise in the next decade.

Table 5.30. Correlations of the relative importance of economic, environmental and social performances with other farmer characteristics

	Importance (%) of Economic Performance
2000 Relationships with SC	.488(**)
2000 Community and Local Interests	-.439(*)
2000 Merchants	.511(**)
2000 Local Community	-.370(*)
Relationships with Local Community Improved	-.406(*)
Increase Yields	.367(*)
Increase Economies of Scale or Specialisation	.451(*)
Participation in Conservation Scheme	.572(**)
	Importance (%) of Environmental Performance
2000 Relationships with SC	-.487(**)
2000 Community and Local Interests	.424(*)
2000 Merchants	-.503(**)
2000 Local Community	.363(*)
Relationships with Local Community Improved	.388(*)
Increase Yields	-.390(*)
Increase Economies of Scale or Specialisation	-.372(*)
Participation in Conservation Scheme	-.385(*)
	Importance (%) of Social Performance
Participation in Conservation Scheme	-.429(*)
** Correlation is significant at the .01 level (2-tailed).	
* Correlation is significant at the .05 level (2-tailed).	
Estimations are based on Kendall's tau-b correlation test	

Finally, farmers' participation in conservation scheme was positively correlated with the importance of social and environmental performance, while it was negatively correlated with importance of economic performance.

5.8. Summary of Chapter

The most important conclusion from the survey of farmers is that their main concern is to remain in business and while environmental and social issues were significantly more important in 2000 than in 1990, profitability was and is the dominant factor in their decision making. Thus, farmers perceive financial and market related factors are more important factors in their decision making about their potato enterprise than environmental and social issues. Hence, it is not surprising that farmers' main influences during the last decade were groups or organisations directly involved in the food supply chain. Moreover, they claimed that financial and market related factors act as greater constraint on their enterprise performance than environmental and social related factors.

Farmers' own assessment of the change in their potato enterprise performance during the last decade revealed that although farmers perceive that their enterprise production efficiency and environmental and social performance significantly improved, profitability slightly decreased and they drew less satisfaction from their business than 10 years ago. Moreover, organic production appears unattractive to the majority of farmers, while deregulation is perceived to have benefited the bigger but not the smaller producers. Farmers believe that they will also have to struggle to stay in business in the next decade and that they will face even stronger competition because of globalisation of food markets. Farmers feel that as well as taking actions to secure satisfactory profitability, they have also to improve their environmental and social performance.

The size of potato enterprise was, to some degree, associated with farmers' perceptions about some aspects of the sustainability of their potato enterprise. Thus, bigger producers reported to have marginally improved more some aspects of their

enterprise performance than smaller producers, they were strong supporters of the deregulation and they also believed that they have to increase even more the size of their enterprise in the future. Rather surprisingly, smaller farmers were significantly more likely to claim increased investment on irrigation and storage than bigger farmers, but it is very probable that bigger farmers had already made significant investments in the past. Thus it was easier for them to face the challenges derived from the changes food supply chain than smaller farmers.

Farmers participating in agri-environmental schemes claimed to have improved aspects of their enterprise environmental and social performance more than those not participating, while farmers carrying out environmental audit reported greater improvement is some aspects of their enterprise environmental performance than those not. The adoption of elements of precision farming was to a small degree associated with improving some aspects of enterprise performance, however farmers adopting were more likely to increase adoption of advanced technology in the future than those not adopting. Staff development schemes were also slightly associated with improving some aspects of enterprise performance, but farmers applying such schemes were more positive of employees' skills improvement in contributing to enterprise sustainability than those not. Moreover, farmers' participation in growers association was associated with slightly better performance in some aspects of their enterprise. Farmers who claimed that to have increased the level of investment in irrigation in the last 10 years were likely to be more aware of water irrigation and management, and they also reported rather higher improvement on their potato enterprise irrigation management during the last decade than those that have not increased.

Conjoint analysis revealed that economic performance is clearly the most important element of sustainability from a farmer's perception. Economic performance is significantly more important than environmental and than social performance, but the latter are statistically of similar importance to farmers' decision making. However, there is a great variation of the relative importance of each performance among farmers.

Farmers showed that they had strong desire to avoid possible negative economic or environmental or social performance. Moreover, it is very important to them to achieve high and reliable financial returns rather than merely acceptable. However, they

seem to be reluctant to demonstrate very strong commitment to a high level of environmental protection and improvement if this means compromising economic performance. What matters more to them is to comply with legal obligations. Finally, high social performance seems to be considerably preferred to medium.

As a conclusion, the findings of farmer survey are in line with the findings of the literature review and the in-depth interviews about the sustainability of fresh potato supply chain during the last decade. Improving profitability remains farmers' major concern. However it is evident that moderate and increasing environmental and social standards are prerequisites to stay in business. In general, farmers were satisfied with their enterprise's changes in performance in the last 10 years, except with profitability. Competition is expected to be stronger in the future, while farm assurance schemes will be dominant. Hence they perceive that they still have to improve their potato eneterprise productivity and efficiency. Finally, for the whole sample, economic performance is significantly more important than environmental or social when farmers choose production systems, while environmental and social have statistically the same degree of importance. However, two thirds of the respondents seem to believe that it is possible for economic, environmental and social performance to go 'hand by hand', which is very encouraging for the sustainability of potato farming.

CHAPTER 6

MERCHANTS' PERCEPTIONS OF SUSTAINABILITY

6.1 Introduction

Results from the survey of potato merchants are reported in this chapter. Initially, the profile of the respondents to this survey is presented. The chapter, then deals with the perceived importance of selected factors in the decision making of merchants, the influence of people or organizations on the way merchants manage their potato business and the importance of selected factors limiting their business performance. Afterwards, the self-assessment of merchants about the changes in their potato business performance during the last decade and their attitudes towards the trade-off between the three elements of sustainability, economic, environmental and social are reported. Finally, the results from the conjoint analysis which explores the relative importance of these three elements are presented.

6.2. Profile of the Participants in Merchants' Survey

The great majority of potatoes traded by the sample of merchants (on average 69% of the volume of respondents) were supplied to major retailers and 90%, on average of the potato volume bought by merchants was produced under farm assurance schemes (Table 6.1). Processors and wholesale markets were the other major markets (17.8% and 9.7%, respectively) that merchants supplied potatoes.

Moreover, the great majority of potatoes (on average 75% of the volume of respondents) were sourced from dedicated farmers, a considerable volume (18%) from occasional farmers and a small amount (7%) from abroad. The annual average volume of business for the participants was high (around 180 thousands tonnes), but there was great variation among merchants ranging from 20,000 tonnes to 750,000 tonnes per year (Table 6.1).

Table 6.1. Descriptive statistics of merchants' profile

	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
					25	50	75
Business Volume (Tonnes)	180529		20000	750000	30500	80000	135000
Percentage of Potatoes Sourced from Abroad	7.1	257869	0	35	1	5	10
Percentage of Potatoes Sourced from Dedicated Farmers	75	8.8	20	100	65	75	92.5
Percentage of Potatoes Sourced from Occasional Farmers	17.7	21.36	0	75	2.5	10	26
Percentage of Potatoes Supplied to Wholesale Market	9.6	19.06	0	38	3	10	15
Percentage of Potatoes Supplied to Major Retailers	68.7	9.48	30	100	55	70	82.5
Percentage of Potatoes Supplied to Small Retailers	1.2	20.53	0	5	0	0	2.5
Percentage of Potatoes Supplied to Caterers	2.5	2.19	0	10	0	0	5
Percentage of Potatoes Supplied to Processors	17.8	3.06	0	55	5	15	32.5
Percentage of ICM Produced Potatoes	89.7	18.01	25	100	90	100	100
Percentage of Organic Potatoes	1.6	19.62	0	8	0	1	2.5

Table 6.2. Frequencies Statistics (valid percent) of merchants' sustainability actions

	YES	NO	Do not know
Carrying out Environmental Audit	70.6	11.8	17.6
New Technologies to Minimise Refrigerant Emissions	52.9	41.2	5.9
New Technologies to Minimise Transportation Emissions	76.5	17.6	5.9
New Technologies to Improve Water Recycling	88.2	11.8	
New Technologies to Save Energy	94.1	5.9	
Staff Development/Training Scheme	100		
Participation in Packers Association	88.2	11.8	
Increased Investment on Waste Recycling	88.2	11.8	
Increased Investment on Refrigeration	94.1	5.9	
Increased Investment on Storage	88.2	11.8	
Increased Investment on Grading	100		
Increased Investment on Washing	100		
Increased Investment on Transportation	64.7	35.3	
Increased Investment on Packaging	88.2	11.8	
Increased Investment on Energy Management	88.2	11.8	
Increased Investment on Water Management	94.1	5.9	

The great majority of the respondents reported that they carried out environmental audit. Moreover, more than half of merchants reported to have adopted new technologies to minimise refrigerant emissions and the great majority of them adopted new technologies to minimise transportation emissions, improve water recycling and save energy. All merchants also claimed that they have staff development scheme in place and around 90% of them participated in packers association. Moreover, around 90% of participants claimed to have increased investment on all major areas of their business, except on transportation, where 65% of them claimed to have done so, but this relatively low increase may be attributed to the fact that it is quite common practice for merchants to use haulage contractors (Table 6.2).

6.3. Importance of Factors on the Sustainability of Merchants' Fresh Potato Business

6.3.1. Selection of statistical tests

Friedman, Wilcoxon Signed Ranks and Kendall's tau tests, as well as Descriptive and Frequencies statistics described in § 5.3.1 were selected to analyse merchants' perceptions about factors importance on the sustainability of their fresh potato business (Field, 2000).

6.3.2. Importance of selected factors on merchants' decision making

The Friedman test showed that there was significant difference in the relative importance of the selected factors in merchants' management decisions for their potato business in 2000 (Table 6.4). However, it is interesting to mention that almost all factors were perceived to be very important (mode & median=4 or 5), except for community and local interests (mode & median=3) (Table 6.3). In particular, profitability (mode & median=5) was the most important factors, but it was very closely followed in importance by environmental risk, food product safety and quality, relationships with SC and market requirements (mode & median=4 or 5). Thus, merchants seem to almost equally take into consideration all economic, market, environmental and social factors in 2000, realising that staying in business involves more than merely economic performance.

There was also significant difference in the relative importance of the selected factors perceived by merchants' in their management decisions in 1990 (Table 6.4). Profitability (mode & median=4) was the most important factor in merchant's management decisions, while relationships with the SC, business uncertainty and market requirements (mode= 4 or 3 & median=4) were the next most important factors (Table 6.3). Environmental and social related factors (i.e. natural resources management, environmental risk and community and local interests) were the least (mode= 2 or 3 & median=3) important factors to merchants decision making. Thus,

merchants were driven more by economic and market factors than environmental and social factors in 1990.

Table 6.3. Descriptive Statistics of the importance of factors influencing merchant decisions on potato business management

	Mode	Median	Mean	Std. Deviation
2000 Profitability	5	5	4.76	0.56
2000 Natural Resources Management	4	4	4.18	0.81
2000 Environmental Risk	5	5	4.53	0.51
2000 Personnel Management	4	4	3.94	0.43
2000 Business Uncertainty	4(a)	4	4.24	0.75
2000 Relationships with SC	4	4	4.41	0.51
2000 Market Requirements	4(a)	4	4.41	0.62
2000 Food Product Safety and Quality	5	5	4.53	0.62
2000 Community and Local Interests	3	3	3.47	0.51
2000 Use of New Technologies	4	4	4	0.61
1990 Profitability	4	4	4.35	0.61
1990 Natural Resources Management	2	3	2.81	1.05
1990 Environmental Risk	3	3	2.82	0.88
1990 Personnel Management	3	3	3.18	0.53
1990 Business Uncertainty	4	4	3.65	0.79
1990 Relationships with SC	4	4	3.94	0.66
1990 Market Requirements	3	4	3.71	0.77
1990 Food Product Safety and Quality	3	3	3.47	0.87
1990 Community and Local Interests	3	3	2.65	0.7
1990 Use of New Technologies	3	3	3.24	0.97
a Multiple modes exist. The smallest value is shown				

Profitability was the most important factor in merchants' decision making for their potato enterprise in both 2000 and 1990 (Table 6.4). Environmental risk, and food product safety and quality gained a lot of relative importance during 1990-2000. While relationships with SC and business uncertainty ranked higher in 1990 than in 2000, they were among the most important factors in both 1990 and 2000. Moreover, natural resources management and community and local interests were of the same importance in merchants' decision making between 1990 and 2000. Thus, environmental and some market related factors gained more relative importance during the last decade. However,

it is important repeating that almost all factors were equally important in 2000, so in this case it is relevant to examine the changes in factors importance over the decade.

Table 6.4. Relative importance of factors influencing merchant decisions on potato business management

Ranks based on Friedman Test				
	1990 Mean Rank	2000 Mean Rank	1990 Rank	2000 Rank
Profitability	8.75	7.65	1	1
Natural Resources Management	3.88	5.29	8	7
Environmental Risk	3.88	6.62	9	3
Personnel Management	4.66	4.15	7	9
Business Uncertainty	6.25	5.47	3	6
Relationships with SC	7.16	6.06	2	5
Market Requirements	6.19	6.15	4	4
Food Product Safety and Quality	5.69	6.68	5	2
Community and Local Interests	3.16	2.44	10	10
Use of New Technologies	5.41	4.5	6	8

Test Statistics[a]		
	1990	2000
N	16	17
Chi-Square	56.473	50.725
Df	9	9
Asymp. Sig.	.000	.000
a Friedman Test		

Wilcoxon Signed Ranks test showed that all the selected factors were perceived to be significantly more important in merchants' decision making in 2000 than they used to be in 1990 (Table 6.5). However, there was some variation in the increase of their importance during 1990-2000. Higher Z values indicate greater increase of importance. Environmental risk, natural resources management, food product safety and quality became much more important in farmers' decision management in 2000 than they used to be in 1990.

Table 6.5. Changes in the relative importance of factors influencing merchant decisions on potato business management

	Z [(w)]
1990 Profitability - 2000 Profitability	-2.111(a) (*)
1990 Natural Resources Management - 2000 Natural Resources Management	-3.372(a) (**)
1990 Environmental Risk - 2000 Environmental Risk	-3.588(a) (**)
1990 Personnel Management - 2000 Personnel Management	-3.606(a) (**)
1990 Business Uncertainty - 2000 Business Uncertainty	-2.308(a) (*)
1990 Relationships with SC - 2000 Relationships with SC	-2.828(a) (**)
1990 Market Requirements - 2000 Market Requirements	-2.972(a) (**)
1990 Food Product Safety and Quality - 2000 Food Product Safety and Quality	-2.994(a) (**)
1990 Community and Local Interests - 2000 Community and Local Interests	-2.810(a) (**)
1990 Use of New Technologies - 2000 Use of New Technologies	-2.667(a) (**)
[w]. Wilcoxon Signed Ranks Test	
a Based on positive ranks. The 2000 mean value is higher than 1990 value	
** Difference of means is significant at the .01 level (2-tailed).	
* Difference of means is significant at the .05 level (2-tailed).	

Frequencies and descriptive statistics showed that on average the variability of merchants' answers for factors importance in both 1990 and 2000 was similar, but there was more convergence in the responses for use of new technologies and environmental risk in 2000 than in 1990 (Table 6.3).

The most important finding from the above analyses is that, all the selected factors were perceived to be significantly more important in merchants' management decisions for their potato business in 2000 than they used to be in 1990. This can be attributed, inter alia, to the fierce competition among merchants (now less than 25 of them supply the major retailers), consumers' concerns over food product safety and quality, and retailers' requirements that businesses producing and supplying foodstuffs to them meet high sustainability standards. Such standards include high product quality, increased environmental protection, prudent use of natural resources, high efficiency gains and increased profitability. Thus, it seems that for merchants, like for farmers, meeting these high sustainability standards is difficult and those merchants remaining need to be more efficient and better integrated with the rest of the supply chain.

While it is clear that a broad range of factors influence merchants' management decisions (mode & median=4 or 5), profitability was the most important factor in 2000, closely followed by environmental risk, food product safety and quality, relationships with SC and market requirements. Community and local interests were of moderate to high importance. This finding indicates that merchants believe that apart from high financial returns and closer relationships with actors of the supply chain, prudent use of natural resources, protection of the environment and improvement of social capital is also necessary for successful business. This is not surprising, considering that major retailers require from their few suppliers to raise environmental and social business standards.

6.3.4. Importance of groups or organizations influence on merchants

Significant difference was found on the relative influence of groups or organisations on the way merchants managed their potato business in 2000 (Table 6.7). Retailers were perceived to be the most important influence (mode=5), followed by growers and consumers (mode=4) and regulatory authorities (mode=4). Most of the other influences were perceived to be moderately important (mode=3). Consumer organizations and packers' organizations were the least (mode=3, median=2) important influences (Table 6.6).

Friedman test showed that there is also significant difference in the influence of groups or organisations on the way merchants managed their potato business in 1990 (Table 6.7). Retailers were by far the most important influence (mode=4), followed by farmers (mode=4) and to lesser extent consumers (mode=3). All the other factors were either of moderate (mode=3) or little importance (mode=2) (Table 6.6).

Wilcoxon Signed Ranks test (Table 6.8) showed that several influences were more important in 2000 than in 1990. In particular, regulatory authorities and consumers were perceived by merchants to have increased very much their influence during the last decade. Non-governmental environmental organisations, advisors and research

institutions showed a relatively moderate change in the importance of their influence during 1990-2000, while growers and consumer organisations a marginal change.

Table 6.6. Descriptive Statistics of the importance of groups or organisations influencing merchant decisions on potato business management

	Mode	Median	Mean	Std. Deviation
2000 Retailers	5	5	4.59	1.06
2000 Farmers	4	4	4.12	0.49
2000 Consumers	4	4	4.18	0.73
2000 Advisor/Consultant	3	3	2.59	0.94
2000 Other Suppliers/Packers	3	3	3.24	0.56
2000 Local Community	3	3	2.94	0.75
2000 Regulatory Authorities	4	4	3.88	0.78
2000 Academic/Research Institutions	3	3	2.65	0.61
2000 NG Environmental Organisations	3	3	2.59	0.94
2000 Consumer Organisations	3	2.5	2.25	0.89
2000 British Potato Council	3	3	2.88	0.7
2000 Supplier/Packers Organisation	3	2	2.35	0.86
1990 Retailers	4	4	4.29	0.77
1990 Farmers	4	4	3.71	0.69
1990 Consumers	3	3	3.29	0.85
1990 Advisor/Consultant	2	2	1.94	0.66
1990 Other Supplier/Packers	3	3	2.94	0.66
1990 Local Community	2	2	2.53	0.94
1990 Regulatory Authorities	2	2	2.41	0.94
1990 Academic/Research Institutions	2	2	2	0.61
1990 NG Environmental Organisations	2	2	1.88	0.7
1990 Consumer Organisations	2	2	1.94	0.66
1990 British Potato Council	3	3	2.88	0.7
1990 Supplier/Packers Organisations	3	3	2.71	0.92

Frequencies and descriptive statistics showed that on average the variability of merchants' answers for factors importance in both 1990 and 2000 was almost similar (Table 6.6).

The key conclusion is that merchants perceived that a wide range of the selected groups or organisations exerted an increased influence, to different extent, during 1990-

2000. Moreover, the most important influences for both 1990 and 2000 are from within the supply chain itself, namely, retailers, growers and consumers (the latter increasing their influence significantly). Regulatory authorities demonstrated the greatest increase in influence over the period associated with increased environmental, social and food safety legislation. Thus, merchants seem to perceive that they are significantly influenced by all those involved in the fresh potato supply chain (farmers, retailers and government).

Table 6.7. Relative importance of groups or organisations influencing merchant decisions on potato business management

Ranks based on Friedman Test				
	1990 Mean Rank	2000 Mean Rank	1990 Rank	2000 Rank
Retailers	10.00	9.71	1	1
Farmers	8.79	8.91	2	2
Consumers	7.56	8.85	3	3
Advisor/Consultant	3.38	3.91	10	8
Other Supplier/Packers	6.74	5.85	4	5
Local Community	5.44	4.91	7	6
Regulatory Authorities	4.91	8.24	8	4
Research Institutions	3.53	3.91	9	9
NG Environmental Organisations	3.06	3.88	11	10
British Potato Council	6.56	4.59	5	7
Packers Organisations	6.03	3.24	6	11

Test Statistics[a]		
	1990	2000
N	17	17
Chi-Square	91.752	106.387
df	10	10
Asymp. Sig.	.000	.000
a Friedman Test		

Other suppliers, British Potato Council and packers' organisations (mode=3) were moderately important influences during 1990-2000. Business advisors and research institutions were more important in 2000 (mode=3) than in 1990 (mode=2).

Once more it is becoming evident that merchants make most of their decisions taking into consideration mainly the growers and retailers they co-operate with, as well as consumer and legal requirements. Moreover, local community, non-governmental environmental and consumer organisations remained the least important influences on the way merchants managed their business, although they had increased their influence over time.

Table 6.8. Changes in the relative importance of groups or organisations influencing merchant decisions on potato business management

	$Z^{(w)}$
1990 Retailers - 2000 Retailers	-1.667(a)
1990 Growers - 2000 Growers	-2.111(a) (*)
1990 Consumers - 2000 Consumers	-3.217(a) (**)
1990 Advisor/Consultant - 2000 Advisor/Consultant	-2.598(a) (**)
1990 Other Supplier/Packers - 2000 Other Suppliers/Packers	-1.667(a)
1990 Local Community - 2000 Local Community	-1.941(a)
1990 Regulatory Authorities - 2000 Regulatory Authorities	-3.473(a) (**)
1990 Research Institutions - 2000 Research Institutions	-3.051(a) (**)
1990 NGOs - 2000 NG Environmental Organisations	-2.972(a) (**)
1990 Consumer Organisations - 2000 Consumer Organisations	-2.000(a) (*)
1990 British Potato Council - 2000 British Potato Council	0.000(b)
1990 Packers Organisations - 2000 Packers Organisation	-1.218(c)
[w]. Wilcoxon Signed Ranks Test	
a Based on positive ranks. The 2000 mean value is higher than 1990 mean value	
b The sum of negative ranks equals the sum of positive ranks.	
c Based on negative ranks. The 1990 mean value is higher than 2000 mean value	
* Difference of means is significant at the .05 level (2-tailed).	
** Difference of means is significant at the .01 level (2-tailed).	

6.3.5. Importance of selected factors limiting potato business performance

Table 7.10 shows that there was a significant difference in the extent that merchants perceived the selected factors limited their potato business performance in 2000. Variability of potato quality (median=4, mode=3) and relationships with retailers were perceived to be the most (mode=3) important limiting or constraining factor (Table 6.9), followed by variability of potato price, quality of labour force and

availability of potato quantity (mode=4 or 3). Relationships with growers (mode=3) were moderately limiting, while information about market needs, financial resources and availability of technology (mode=3) were the least limiting factors (Table 6.9).

Table 6.9. Descriptive Statistics of the importance of factors limiting the performance of merchant potato business

	Mean	Median	Mode	Std. Deviation
2000 Quality of Labour Force	3.24	3	3	1.15
2000 Relationships with Retailers	3.47	3	3	0.87
2000 Relationships with Growers	3	3	3(a)	0.94
2000 Information about Market Needs	2.71	3	3	0.85
2000 Financial Resources	2.71	3	3	1.1
2000 Variability of Potato Quality	3.59	4	3	1.12
2000 Availability of Potato Quantity	3.18	3	4	1.19
2000 Variability of Potato Price	3.29	3	4	0.99
2000 Availability of Technology	2.65	3	3	0.86
1990 Quality of Labour Force	2.59	2	2	1
1990 Relationships with Retailers	3.65	4	3	0.7
1990 Relationships with Growers	2.76	3	3	0.9
1990 Information about Market Needs	2.76	3	3	0.97
1990 Financial Resources	2.47	3	3	1.12
1990 Variability of Potato Quality	3.29	3	4	0.99
1990 Availability of Potato Quantity	3	3	3	1
1990 Variability of Potato Price	3.12	3	4	0.93
1990 Availability of Technology	2.76	3	3	0.9
a Multiple modes exist. The smallest value is shown				

Significant difference was also found in the extent that selected factors limited the performance of merchants' potato business in 1990 (Table 6.10). Relationships with retailers were considered the most (mode=4) important constraining factor, followed by variability of potato quality, of potato price and of potato quantity (mode=3). All the other factors exhibited moderate limitation (mode=2 or 3) (Table 6.9).

Frequencies and descriptive statistics showed that on average the variability of answers on factors limiting importance for both 1990 and 2000 were almost similar (Tables 6.9).

Table 6.10. Relative importance of factors limiting the performance of merchant potato business

Ranks based on Friedman Test				
	1990 Mean Rank	2000 Mean Rank	1990 Rank	2000 Rank
Quality of Labour Force	4	5.35	9	4
Relationships with Retailers	6.88	6.06	1	2
Relationships with Farmers	4.62	4.79	5	6
Information about Market Needs	4.53	3.94	6	7
Financial Resources	4.09	3.65	8	9
Variability of Potato Quality	5.97	6.56	2	1
Availability of Potato Quantity	4.97	5.21	4	5
Variability of Potato Price	5.5	5.68	3	3
Availability of Technology	4.44	3.76	7	8

Test Statistics[a]		
	1990	2000
N	17	17
Chi-Square	20.623	25.146
df	8	8
Asymp. Sig.	0.008	0.001
a Friedman Test		

Friedman test revealed that variability of potato quality and relationships with retailers were perceived to be the most important limiting the performance of potato business in 2000, as well as in 1990 (Table 6.10). Variability of potato price and availability of potato quantity were the next most limiting factors. Quality of labour force increased significantly as a perceived limitation during the last decade to become the fourth most limiting in 2000.

Quality of labour force was the only of the selected factors that was significantly more limiting in 2000 than they used to be in 1990 (Table 6.11). The rest of the selected factors appeared to have some differences in their means or modes between 1990 and 2000, but because of the small magnitude of the differences and the small number of the sample (17 merchants) these were not statistically significant.

Table 6.11. Changes in the relative importance of factors limiting the performance of merchant potato business

	$Z^{(w)}$
1990 Quality of Labour Force - 2000 Quality of Labour Force	-2.296(a) (*)
1990 Relationships with Retailers - 2000 Relationships with Retailers	-.905(c)
1990 Relationships with Farmers - 2000 Relationships with Farmers	-1.027(a)
1990 Information about Market Needs - 2000 Information about Market Needs	-.302(c)
1990 Financial Resources - 2000 Financial Resources	-.877(a)
1990 Variability of Potato Quality - 2000 Variability of Potato Quality	-1.311(a)
1990 Availability of Potato Quantity - 2000 Availability of Potato Quantity	-.584(a)
1990 Variability of Potato Price - 2000 Variability of Potato Price	-1.000(a)
1990 Availability of Technology - 2000 Availability of Technology	-.577(c)
[w]. Wilcoxon Signed Ranks Test	
a Based on positive ranks. The 2000 mean value is higher than 1990 mean value	
c Based on negative ranks. The 1990 mean value is higher than 2000 mean value	
* Difference of means is significant at the .05 level (2-tailed).	

Product and market related factors were the most limiting in both 1990 and 2000, but many other factors were perceived to be moderately limiting. Variability of the potato quality and price were among the key limiting factors to merchants' potato business performance during 1990-2000. This confirms the findings of the in-depth interviews that pointed the uncertainty of potato quality, price and quantity that merchants face. Merchants reported that they wish to exploit economies of scale to achieve reduction in unit costs and supply retailers with guaranteed continuous supplies of fresh potatoes throughout the whole year.

Relationships with retailers were also among the top limiting (mode=3) factors for merchants' business performance during 1990-2000. Good relationships with retailers are a key success factor for merchants, because retailers have much greater relative bargaining power. Moreover, the competition among a reduced number of merchants is very fierce and thus it is a major threat for their business to be disqualified from the supplier list of major retailers.

Relationships with growers were moderately important in limiting merchants' business performance for both 1990 and 2000. Conversely, farmers also perceived that relationships with merchants were a moderate limitation on their potato enterprise performance. Good relationships between merchants and growers are critical for the supply chain as a whole. In a market driven system, however, the backward link from merchant to farmer is essential to ensure production is suited to end-user needs.

The quality of labour force is emerging as an additional factor with negative impact on merchants' business. In fact, the quality of the labour force was the only factor that significantly increased its relative importance between 1990 and 2000. This can be attributed to the adoption of new technologies, which require high labour skills, and the fact that many young people prefer to live and work in more metropolitan places than the relatively remote places where most of packing houses are located. The in-depth interviews also revealed that some merchants have thought of using robots in order to overcome the lack of adequately skilled workforce.

Information about market needs, availability of technology and financial resources were a relatively minor limitation on merchants during 1990-2000. Merchants believe that they are relatively well informed about market needs and that availability of technology is not a major barrier to the prosperity of their business, in contrast to farmers who would wish to have better access to marketing data. Moreover, financial resources are not seen as a major issue of concern, especially among these relatively large merchants.

6.4. Merchants' Self-Assessment on the Changes of the Performance of their Potato Business During 1990 and 2000

Descriptive and Frequencies statistics described in §5.4.1 were found useful to analyse merchants' self-assessment on the changes of the performance of their potato business during 1990 and 2000.

The most important conclusion from merchants' self-assessment is that, on average, their potato business performance had significantly improved according to the

selected sustainability indicators over the last 10 years, with the exception of profitability, on which views varied (Tables 6.12 and 6.13). In fact, there is almost a normal distribution around average response 'neither agree nor disagree' whether profitability had increased.

More respondents agreed that the services offered by their business have improved and potatoes sold were of higher quality than 10 years ago. This can be attributed, inter alia, to the fact that their knowledge about market needs has very significantly improved, the wide adoption of farm assurance schemes and the closer links with retailers, who repeatedly demand higher quality products. Not surprisingly, the use of Information Technology (median=7) has also increased very significantly. These findings were expected as merchants that supply major retailers are much more market driven now (median and mode=6) than ten years ago using IT to help organize, and administer their business.

Over 80% of merchants reported improved relationships with retailers, growers and their employees (median and mode=6) over the last decade. This is very crucial nowadays because strong relationships among the businesses involved in the fresh potato supply chain is a prerequisite to improve supply chain performance and meet increasing consumer requirements. Rather surprisingly, merchants, on average, have slightly (mode=4) improved their relationships with the local community, reflecting that most of their employees come from the local community.

Merchants also reported considerable improvement of their employees' skills and the increase of output per worker (median and mode=6). Moreover, merchants perceived that risk of environmental pollution from their potato business has reduced (median=7) and natural resources management has improved (median and mode=6). These perceptions could also be attributed to the high environmental and social standards imposed either from retailers or from government and regulatory authorities, which was mentioned in the literature review.

Merchants' perceptions of the trade-offs between the sustainability elements of business performance, the benefits of organic potatoes and the deregulation of potato industry were rather variable (standard deviation 1.46-2.03) (Table 6.13). On average,

Table 6.12. Frequencies Statistics (Valid Percent) of merchant's self-assessment on the changes of the performance of their potato business during 1990 and 2000 and opinions on the trade-offs between sustainability elements

	Totally Disagree	Mostly Disagree	Slightly Disagree	Neither Agree Nor Disagree	Slightly Agree	Mostly Agree	Totally Agree
Output Per Worker Increased			5.9	5.9	17.6	41.2	29.4
Relationships with Retailer Improved	5.9	5.9	5.9		52.9	29.4	
Relationships with Growers Improved				5.9	17.6	58.8	17.6
Relationships with Employees Improved				11.8	11.8	58.8	17.6
Relationships with Local Community Improved				37.5	31.3	18.8	12.5
Services Offered Improved				5.9	5.9	23.5	64.7
Potatoes are of Higher Quality				6.3		25	68.8
Knowledge of Market Needs Improved				6.3	12.5	43.8	37.5
Use of IT Increased				5.9	11.8	23.5	58.8
Overall Profitability Improved	5.9	5.9	23.5	29.4	23.5	11.8	
Natural Resources Management Improved				11.8	11.8	58.8	17.6
Environmental Pollution Risk Reduced				5.9		41.2	52.9
Employees Skills Improved				5.9		64.7	29.4
Reducing Environmental Risk Brings Financial Benefits	17.6	5.9	11.8	11.8	35.3		17.6
Financial Benefits Exceed Costs from Skills Improvement		12.5			25	31.3	31.3
Improving Skills Benefits Environment		18.8		18.8	37.5	18.8	6.3
Organic Have Environmental AND Financial Benefits for My Business	17.6	23.5		29.4	11.8	11.8	5.9
Organic Have Environmental AND Financial Benefits for Whole SC	25	12.5	12.5	31.3	6.3	6.3	6.3
Deregulation Has Been a Good Thing			11.8	11.8	11.8	23.5	41.2

Table 6.13. Descriptive Statistics of merchant's self-assessment on the changes of the performance of their potato business during 1990 and 2000 and opinions on the trade-offs between sustainability elements

	Mean	Mode	Std. Deviation	Minimum	Maximum	Percentiles		
						25	50	75
Output Per Worker Increased	5.8	6	1.1	3	7	5	6	7
Relationships with Retailer Improved	5.8	6	1.6	1	7	6	6	7
Relationships with Growers Improved	5.9	6	0.8	4	7	6	6	6
Relationships with Employees Improved	5.8	6	0.9	4	7	6	6	6
Relationships with Local Community Improved	5.1	4	1.1	4	7	4	5	6
Services Offered Improved	6.5	7	0.9	4	7	6	7	7
Potatoes are of Higher Quality	6.6	7	0.8	4	7	6	7	7
Knowledge of Market Needs Improved	6.1	6	0.9	4	7	6	6	7
Use of IT Increased	6.4	7	0.9	4	7	6	7	7
Overall Profitability Improved	3.9	4	1.3	1	6	3	4	5
Natural Resources Management Improved	5.8	6	0.9	4	7	6	6	6
Environmental Pollution Risk Reduced	6.4	7	0.8	4	7	6	7	7
Employees Skills Improved	6.2	6	0.7	4	7	6	6	7
Reducing Environmental Risk Brings Financial Benefits	4.1	5	2	1	7	3	5	5
Financial Benefits Exceed Costs from Skills Improvement	5.6	6(a)	1.6	2	7	5	6	7
Improving Skills Benefits Environment	4.6	5	1.5	2	7	4	5	5.8
Organic Have Environmental AND Financial Benefits for My Business	3.5	4	1.9	1	7	2	4	5
Organic Have Environmental AND Financial Benefits for Whole SC	3.3	4	1.8	1	7	1	4	4
Deregulation Has Been a Good Thing	5.7	7	1.5	3	7	5	6	7

a Multiple modes exist. The smallest value is shown

merchants slightly agreed that reducing environmental risk brings financial benefits to their business (median and mode=5). However, the great majority of respondents (87%) agreed that financial benefits exceed costs from skills improvement (median and mode=6). Moreover, on average, merchants slightly agree (median and mode=5) that improving employees skills benefits environment.

Although there was great dispersion of answers, on average, merchants are not convinced (median and mode=4) that organic potatoes can bring both environmental and financial benefits either to their business or to the whole supply chain. Finally, merchants, on average, mostly agreed (median=6 and mode=7) that deregulation has been a good thing for the industry.

6.5. Relative Importance of Economic, Environmental and Social Objectives on Merchants' Choice for Supply Chain Systems

6.5.1. Introduction

Conjoint analysis aimed to identify the relative importance of economic, environmental and social performance as they influence merchants to choose fresh potato supply (growers-supplier) systems.

6.5.2. Selection of statistics

The SPSS Conjoint procedure has been used to analyse the data derived from the 9 questionnaires with valid answers (SPSS, 1998). Descriptive statistics, as well as Friedman and Wilcoxon Signed Ranks tests were also used (§5.7.2).

6.5.3. Part-worth evaluations

Part-worth evaluations (Table 6.14) are all based on the same preference score rating, hence, the total evaluation of a scenario derives from adding the part-worth

evaluations of its attribute levels. The predicted total evaluations (from the Conjoint Analysis results) should correspond closely to the actual preference scores of respondents. Table 7.15 shows that predicted preference scores are quite close to the actual for scenarios 1, 2, 4, 5 and 8. However, the predicted evaluations were higher than the actual for scenarios 3 and 6, while the opposite happened with scenarios 7 and 9. This can be attributed to the small number of questionnaires (only 9), which included valid answers and could therefore be considered for conjoint analysis.

Table 6.14. Averaged conjoint results for the whole sample of merchants

Attribute Level	Part-worth Evaluation	Relative Importance of Attribute
Constant	**4.358**	
Economic Performance		**39.77%**
Low	-2.2381	
Medium	0.127	
High	2.1111	
Environmental Performance		**31.54%**
Low	-1.6914	
Medium	0.6367	
High	1.0547	
Social Performance		**28.69%**
Low	-1.649	
Medium	0.4198	
High	1.2293	
Pearson's R		**0.98**
Kendall's tau for 2 holdouts		**1**

6.5.4. Reliability of results

Pearson's R correlation coefficient was 0.98 for the whole sample, which is very close to 1, indicating that the model was a good fit (Table 6.14). Moreover, Pearson's R correlation coefficients for each individual respondent ranged between 0.95 and 0.994, showing that merchants were consistent in their preferences. Additionally, Kendall's tau statistic for the hold-out scenarios was 1 for the whole sample indicating that the model was a good fit.

Table 6.15. Scenario predicted and actual preference scores and ranks for the whole merchant sample

Scenario	Predicted Preference Scores	Predicted Rank	Actual Preference Scores	Actual Rank
1	3.13	7	3,2	6
2	6.77	2	6,6	2
3	3.59	5	2,75	7
4	6.35	3	6,45	3
5	1.66	8	1,95	9
6	5.46	4	4,5	4
7	7.53	1	8,1	1
8	3.21	6	3,55	5
9	1.53	9	2,25	8

Table 6.16. Descriptive Statistics of the relative importance of attributes on merchant choice of supply chain systems

	N	Mean	Std. Deviation	Minimum	Maximum	Percentiles		
						25	50	75
Importance (%) of Economic Performance	9	39.77	16.30	14.63	64.72	29.03	38.74	51.86
Importance (%) of Environmental Performance	9	31.54	15.90	6.74	56.9	22.35	26.82	48.49
Importance (%) of Social Performance	9	28.69	8.77	15.52	40	19.89	31.54	35.56

6.5.5. Relative importance of the attributes

Friedman and Wilcoxon Signed Ranks tests found that no one criterion of performance was significantly more important than any other for the way merchants choose supply systems (Tables 6.17 and 6.18). This may be attributed to the small size of the sample, as well as to the great dispersion of values for each performance (Table 6.16). However, on average, merchants considered economic performance to 39.8%, while environmental to 31.5% and social to 28.7% in their decision-making. However,

there was a great variation in merchants' views, which could be attributed, among other reasons, to perceptions of the individuals that filled in the form.

Table 6.17. The relative importance of attributes on merchant choice of supply chain systems (Friedman Test)

Ranks	
	Mean Rank
Importance (%) of Economic Performance	2.44
Importance (%) of Environmental Performance	1.78
Importance (%) of Social Performance	1.78

Test Statistics(a)	
N	9
Chi-Square	2.667
df	2
Asymp. Sig.	.264
a Friedman Test	

Table 6.18. The relative importance of attributes on merchant choice of supply chain systems (Wilcoxon Signed Ranks Test)

Test Statistics(b)			
	Importance (%) of Environmental Performance - Importance (%) of Economic Performance	**Importance (%) of Social Performance - Importance (%) of Economic Performance**	**Importance (%) of Social Performance - Importance (%) of Environmental Performance**
Z	-.770 (a)	-1.362 (a)	-.059 (a)
Asymp. Sig. (2-tailed)	.441	.173	.953
a Based on positive ranks.			
b Wilcoxon Signed Ranks Test.			

Apart from the relative importance of each attribute, the part-worth of attribute levels indicate the relative preference for high, medium and low scores for any one attribute (Table 6.14). Thus, merchants are clearly very concerned that economic performance is not low (with risk of losses in some years), and, not surprisingly, they

would mostly prefer to maximise (high) financial return. Merchants also showed a strong preference to avoid low environmental and social performance. Thus, merchants are, one average committed to achieve balanced and sustainable performance in their potato business avoiding as far as possible low performance in any one criterion.

6.6. Summary of Chapter

The most important conclusion from merchants' survey is their belief that staying in business nowadays is a much more complicated task than it used to be 10 years ago. Although, profitability remains the most important factor in merchants' management decisions, it is closely followed in importance by meeting market requirements, closer relationships with the rest of the supply chain, prudent use of the natural resources, environmental protection and enhancing the value of social capital. This can be attributed to the changes, mentioned several times before, in the supply chain, which increased the competition among merchants and raised the expectations of consumers and retailers of the services offered by the supply chain of which merchants are an important part.

Merchants' perceived to be mainly influenced by groups or organisations directly involved in the food supply chain, namely retailers, growers, and consumers. Moreover, government and regulatory authorities have exerted an increased influence on merchants.

Merchants perceive performance as predominantly economic and therefore, they consider that profitability related factors are those that mostly limit the performance of their potato business. Variability of potato quality, quantity and price, as well as, the relationships with the rest of the supply chain and mainly with retailers are considered the most important limiting factors. Quality of labour force is appearing as a new threat that potato merchants have to deal with. Information about market needs, availability of technology and financial resources were limiting factors of minor importance in merchants' potato business performance for both 1990 and 2000. It is also worth

mentioning that merchants perceive that none of the selected factors were severely limiting their business performance during the last decade.

Merchants' self-assessment showed that in general almost all of them perceive that their potato business performance has improved in terms of most of the selected sustainability criteria during the last decade. However, on average, they believe that profitability remained almost the same as 10 years ago. On average, merchants believe that elements of social and economic performance can simultaneously improve, and that social and environmental performance can also, to some extent, improve together. However, they are not sure whether environmental and economic performance can simultaneously improve. On average, merchants do not perceive that organic fresh potatoes can bring both financial and environmental benefits either to their business nor to the whole supply chain. They are, however, rather positive about the deregulation of the potato industry.

Conjoint analysis revealed that economic performance accounted for 40% of their decision making in choosing supply (grower-supplier) systems, while environmental accounted for 32% and social for 29%. However, these estimates were not statistically significant probably due to the small size of the sample, as well as to the great variation in responses by the participants in the survey of merchants.

Merchants perceive themselves to be, like farmers, committed to achieve high performance in terms of economic, environmental and social aspects in their potato business. Low performance is very undesirable to merchants. However, farmers seem to be reluctant to demonstrate very strong commitment to a high level of environmental protection and improvement if this means compromising economic performance.

CHAPTER 7

RETAILERS' PERCEPTIONS OF SUSTAINABILITY

7.1. Introduction

This chapter deals with the results derived from the survey of major retailers. Initially, the profile of the respondents to this survey is presented. Then, retailer representatives' views about the importance of selected factors in their decision making, the influence of groups or organizations on the way they manage their potato business and the importance of selected factors limiting their business performance. Afterwards, retailers' self-assessment for the changes in their fresh potato business performance during the last decade and their attitudes towards the trade-off between the three elements of sustainability (economic, environmental and social) are reported.

Moreover, the results from the conjoint analysis aiming to find out the relative importance of economic, environmental and social performance on the way retailers choose supply chain systems (grower-supplier-retailer) for fresh potatoes are presented. Four out of eight major retailers contacted for the survey answered the questionnaire (50% response ratio). Taking into consideration, the small number of the respondents, as well as the volume of their business, it was thought relevant to report not only the averaged results, but individual answers as well, although taking into consideration confidentiality issues. Thus, retailers' profiles were also made according to their answers.

The findings from the retailer survey reflect the perceptions of individual respondents within the organizations and not necessarily the collective or indeed agreed corporate views.

Table 7.1. Descriptive statistics of retailers' profile

	Cases		Mean	Std. Deviation	Range	Minimum	Maximum
	Valid	Missing					
Business Volume (Tonnes)	2	2	407500	272236	385000	215000	600000
Percentage of Potatoes Sourced from Abroad	3	1	6.7	7.6	15	0	15
Percentage of Potatoes Sourced from UK Wholesale Market	3	1	0	0	0	0	0
Percentage of Potatoes Sourced from Dedicated Suppliers	2	2	92.5	10.6	15	85	100
Percentage of Potatoes Sourced from UK Growers	2	2	0	0	0	0	0
Percentage of ICM Produced Potatoes	4	0	100	0	0	100	100
Percentage of Organic Potatoes	4	0	2.9	2.5	4.5	0.5	5

7.2. Profile of the Participants in Major Retailers' Survey

Retailers were rather cautious answering questions related to their business volume and the sources fresh potatoes (Tables 7.1 and 7.2). Thus, two of the retailers claimed that their business volume is, on average, 407,500 tonnes, while other two of retailers mentioned that 92.5% of the potato volume, on average, comes from dedicated suppliers. Considering the findings from the in-depth interviews it was not surprisingly that retailers claimed that all potatoes sold by them were produced by farm assurance schemes and that all of them claimed that their business volume of organic potatoes to be less than 5%.

Table 7.2. Retailer profile

	Retailer 1	Retailer 2	Retailer 3	Retailer 4
Business Volume (Tonnes)	0	600000	0	215000
Percentage of Potatoes Sourced from Abroad	0	5	*No Value*	15
Percentage of Potatoes Sourced from UK Wholesale Market	0	0	*No Value*	0
Percentage of Potatoes Sourced from Dedicated Suppliers	100	*No Value*	*No Value*	85
Percentage of Potatoes Sourced from UK Growers	0	*No Value*	*No Value*	0
Percentage of ICM Produced Potatoes	100	100	100	100
Percentage of Organic Potatoes	0.5	1	5	5

All retailers, except retailer 1, claimed that they carry out an environmental audit, and that they have adopted new technologies to minimise transportation and refrigerant emissions and to save also energy (Table 7.3). All retailers have staff development scheme in place and all of them, except retailer 4, participate in a retailers' association. Moreover, all of the respondents have increased the level of investment in terms of waste recycling, refrigeration, transportation and energy management. Thus, retailers, in general, claimed that they have undertaken many actions to improve the sustainability of their business.

Table 7.3. Retailer sustainability actions

	Retailer 1	Retailer 2	Retailer 3	Retailer 4
Carrying out Environmental Audit	Do not know	YES	YES	YES
New Technologies to Minimise Refrigerant Emissions	NO	YES	YES	YES
New Technologies to Minimise Transportation Emissions	NO	YES	YES	YES
New Technologies to Save Energy	NO	YES	YES	YES
Staff Development/Training Scheme	YES	YES	YES	YES
Participation in Retailers Association	YES	YES	YES	Do not know
Increased Investment on Waste Recycling	YES	YES	YES	YES
Increased Investment on Refrigeration	YES	YES	YES	YES
Increased Investment on Transportation	YES	YES	YES	YES
Increased Investment on Energy Management	YES	YES	YES	YES

7.3. Importance of Factors on the Sustainability of Retailers' Fresh Potato Business

The relative importance of various factors influencing the sustainability of retailers' potato business between 1990 and 2000 was investigated, including the influence of people or organisations on the way they managed their business, and the extent to which some factors limited retailers' business performance were assessed.

Descriptive statistics, described in § 5.3.1, were used to analyse retailers' answers. Friedman test was also used to find out if there is significant difference among the means of the selected factors and their relative importance was also ranked.

7.3.1. Importance of selected factors on retailers decisions management

The Friedman test showed that there was a significant difference in the relative importance of the selected factors in retailers' management decisions for their business

with respect to fresh potatoes in 2000 (Table 7.5). In particular, retailers unanimously claimed that food product safety and quality (mode=5) was extremely important to their decision-making, closely followed by market requirements (mode=5) and relationships with the supply chain (median=4.5, mode=4). Profitability, business uncertainty and use of new technologies (median=4, mode=3 or 4) were perceived to be rather important by respondents, while natural resources management, environmental risk, personnel management and community and local interests (mode & median=3) were the least important (Tables 7.4 and 7.6).

Table 7.4. Retailer perceptions of the importance of factors influencing potato business decisions

	Retailer 1	Retailer 2	Retailer 3	Retailer 4
2000 Profitability	4	3	5	4
2000 Natural Resources Management	3	3	3	4
2000 Environmental Risk	3	3	3	4
2000 Personnel Management	3	3	3	3
2000 Relationships with SC	4	4	5	5
2000 Business Uncertainty	5	3	3	5
2000 Market Requirements	4	5	5	5
2000 Food Product Safety and Quality	5	5	5	5
2000 Community and Local Interests	3	2	4	3
2000 Use of New Technologies	3	3	5	5
1990 Profitability	4	4	5	4
1990 Natural Resources Management	2	2	2	3
1990 Environmental Risk	2	2	2	3
1990 Personnel Management	1	2	3	3
1990 Relationships with SC	2	3	5	4
1990 Business Uncertainty	2	2	4	4
1990 Market Requirements	2	3	5	5
1990 Food Product Safety and Quality	2	3	5	5
1990 Community and Local Interests	2	1	4	2
1990 Use of New Technologies	2	1	5	4

There was significant difference in the perceived relative importance of the selected factors in retailers' decision making in 1990 (Table 7.5). However, there was considerable variance of answers among respondents for most of the factors. Profitability (mode & median=4) was the most important factor in retailers management decisions in 1990, followed by food product safety and quality, market requirements and relationships with the supply chain (median=4 or 3.5), but answers ranged considerably. Thus, market and financial related factors were the most important in retailers' management decisions in both 1990 and 2000.

Table 7.5. Relative importance of factors influencing retailer decisions on potato business management

Ranks based on Friedman Test				
	1990 Mean Rank	2000 Mean Rank	1990 Rank	2000 Rank
Profitability	8.63	5.88	1	5
Natural Resources Management	3.63	3.5	7	7
Environmental Risk	3.63	3.5	8	8
Personnel Management	2.88	2.88	10	9
Relationships with SC	7.00	7.75	4	3
Business Uncertainty	5.25	6.13	6	4
Market Requirements	7.75	8.13	2	2
Food Product Safety and Quality	7.75	8.75	3	1
Community and Local Interests	3.13	2.63	9	10
Use of New Technologies	5.38	5.88	5	6

Test Statistics[a]		
	1990	2000
N	4	4
Chi-Square	22.964	24.535
df	9	9
Asymp. Sig.	0.006	0.004
a Friedman Test		

With respect to perceived changes in the relative importance of factors influencing retailers' decisions management over the 1990-2000 period, food product safety and quality, market requirements and relationships with the supply chain raised considerably their importance during the last decade and they were the most important

factors in 2000 (Table 7.5). Profitability, lost relative importance during the last 10 years and followed the above mentioned factors in importance in 2000, although it was the most important factor in 1990. This can be attributed to the increasing debate and sensitivity about food safety, the introduction of supply chain management concept in the food supply chain and the restructuring of food supply chain from production-driven to consumer-driven. Business uncertainty and use of new technologies demonstrated the same relative importance in both 1990 and 2000, while natural resources management, environmental risk, personnel management and community and local interests were consistently the least important in retailers' decisions management over the 1990-2000 period.

Table 7.6. Descriptive statistics of the importance of factors influencing retailer decisions on potato business management

	Mode	Median	Mean	Std. Deviation
2000 Profitability	4	4	4	0.82
2000 Natural Resources Management	3	3	3.25	0.5
2000 Environmental Risk	3	3	3.25	0.5
2000 Personnel Management	3	3	3	0
2000 Relationships with SC	4(a)	4.5	4.5	0.58
2000 Business Uncertainty	3(a)	4	4	1.15
2000 Market Requirements	5	5	4.75	0.5
2000 Food Product Safety and Quality	5	5	5	0
2000 Community and Local Interests	3	3	3	0.82
2000 Use of New Technologies	3(a)	4	4	1.15
1990 Profitability	4	4	4.25	0.5
1990 Natural Resources Management	2	2	2.25	0.5
1990 Environmental Risk	2	2	2.25	0.5
1990 Personnel Management	3	2.5	2.25	0.96
1990 Relationships with SC	2(a)	3.5	3.5	1.29
1990 Business Uncertainty	2(a)	3	3	1.15
1990 Market Requirements	5	4	3.75	1.5
1990 Food Product Safety and Quality	5	4	3.75	1.5
1990 Community and Local Interests	2	2	2.25	1.26
1990 Use of New Technologies	1(a)	3	3	1.83
a Multiple modes exist. The smallest value is shown				

Retailers had almost common views about the importance of the selected factors in their decisions management for 2000, but there was less convergence on their perceptions for 1990.

Food product safety and quality was unanimously of extreme importance in retailers decisions making in 2000, while answers for 1990 ranged from little to extremely important. Retailers' concern about food product safety and quality can be attributed to the 'due-diligence' clause of 1990 Food Safety Act and to the raised concerns and expectations of consumers over food quality. Market related factors like market requirements and relationships with the supply chain were also very important in 2000, followed by profitability, the most important factor in 1990. These results confirm the findings of the literature review and the in-depth interviews that the restructuring of the food supply chain, the increased sensitivity on food safety issues, and the increasingly intensive national and global competition in food retail sector resulted to the dominance of market and economic related factors in retailer' decisions management during the last decade.

Environmental and social related factors were, on average the least important on retailers' decision-making factors for both 1990 and 2000. This is because, on the one hand, retailers do not perceive themselves to be involved in such activities that may have crucial negative impacts on the environment to the extent that agricultural production may have. The in-depth interviews revealed that, although, retailers are concerned about the local community and the personnel management, market and economic related factors are really much more important for them to gain retail competitive advantage. Moreover, it is not easy for retailers to raise environmental and social business standards considerably above the legal requirements, as the competition is not only quality driven, but also price driven and they have to report high profits to their shareholders in order to draw funds from the stock market. Thus, retailers usually promote above the legal requirements those environmental or social standards that do not significantly burden their budget.

7.3.2. Importance of people or organizations influence on retailers

Significant difference was found on the influence of people or organisations on the way retailers managed their business with respect to fresh potatoes in 2000 (Table 7.8). However, there was considerable variance of answers among respondents for most of the influences' importance. Almost unanimously retailers claimed to be influenced most by consumers, followed by suppliers and growers (mode=4), while, other retailers (mode=3, median=3.5) were, on average, reported to be less important (Table 7.9). All the other influences were moderately or of little importance (median=2 or 3, mode=2 or 3 or 4).

Table 7.7. Retailer perceptions of the importance of groups or organisations influencing potato business decisions

	Retailer 1	Retailer 2	Retailer 3	Retailer 4
2000 Suppliers/Packers	4	4	5	4
2000 Growers	4	4	5	4
2000 Consumers	4	5	5	5
2000 Business Advisor/Consultant	2	2	2	2
2000 Other Retailers	3	4	3	5
2000 Local Community	4	3	3	3
2000 Regulatory Authorities	3	3	3	4
2000 Academic/Research Institutions	2	1	4	4
2000 NG Environmental Organisations	2	2	4	4
2000 Consumer Organisations	2	2	4	4
2000 British Potato Council	2	3	3	4
2000 Retailers Organisation	2	3	4	No Value
1990 Suppliers/Packers	2	4	5	4
1990 Growers	3	4	5	4
1990 Consumers	3	5	4	5
1990 Business Advisor/Consultant	2	1	1	2
1990 Other Retailers	2	4	2	4
1990 Local Community	2	2	3	3
1990 Regulatory Authorities	2	2	3	4
1990 Academic/Research Institutions	2	1	3	4
1990 NGOs	2	1	2	4
1990 Consumer Organisations	2	2	2	4
1990 British Potato Council	2	2	3	4
1990 Retailers Organisations	2	2	3	No Value

The Friedman test showed that there was also significant difference in the influence of people or organisations on retailers in 1990 (Tables 7.8). However, there was considerable variation of answers among respondents for most of the influences' importance (Table 7.7). The most important influence on retailers were consumers (mode=5, median=4.5), closely followed by growers and suppliers (mode and median=4). All other people or organizations were little or moderately important influences on retailers' decision making (median=2 to 3), but business advisors were very little (mode=1, median=1.5) important.

In general, there was almost no change at all in the relative important of the selected influences on retailers' decisions management over the decade. Thus, consumers were the most important retailers' influence, closely followed by growers and suppliers for both 1990 and 2000.

Table 7.8. Relative importance of groups or organisations influencing retailer decisions on potato business management

Ranks based on Friedman Test				
	1990 Mean Rank	2000 Mean Rank	1990 Rank	2000 Rank
Suppliers/Packers	9	10.5	3	2
Growers	11	10.5	2	2
Consumers	11.17	11.17	1	1
Advisor/Consultant	2.83	2.5	12	12
Other Retailers	6.17	7	4	4
Local Community	6.17	6.83	4	5
Regulatory Authorities	6.17	5.83	4	6
Academic/Research Institutions	4.83	4	9	11
NG Environmental Organisations	3.5	4.67	11	8
Consumer Organisations	4.83	4.67	9	8
British Potato Council	6.17	4.5	4	10
Retailers Organisation	6.17	5.83	4	7

Test Statistics[a]		
	1990	2000
N	3	3
Chi-Square	23.808	22.629
df	11	11
Asymp. Sig.	0.014	0.02
a Friedman Test		

Retailers' answers and the descriptive statistics derived from them revealed that on average there was more convergence in responses in 2000 than in 1990 (Tables 7.7 and 7.9). This was more apparent for suppliers, consumers, business advisor and government and regulatory authorities. This could possibly be attributed to the 'time' bias and probably to the fact that nowadays influences are more clear and dominant than 10 years ago.

Table 7.9. Descriptive Statistics of the importance of groups or organisations influencing retailer decisions on potato business management

	Mode	Median	Mean	Std. Deviation
2000 Suppliers/Packers	4	4	4.25	0.5
2000 Growers	4	4	4.25	0.5
2000 Consumers	5	5	4.75	0.5
2000 Business Advisor/Consultant	2	2	2	0
2000 Other Retailers	3	3.5	3.75	0.96
2000 Local Community	3	3	3.25	0.5
2000 Regulatory Authorities	3	3	3.25	0.5
2000 Academic/Research Institutions	4	3	2.75	1.5
2000 NG Environmental Organisations	2(a)	3	3	1.15
2000 Consumer Organisations	2(a)	3	3	1.15
2000 British Potato Council	3	3	3	0.82
2000 Retailers Organisation	2(a)	3	3	1
1990 Suppliers/Packers	4	4	3.75	1.26
1990 Growers	4	4	4	0.82
1990 Consumers	5	4.5	4.25	0.96
1990 Business Advisor/Consultant	1(a)	1.5	1.5	0.58
1990 Other Retailers	2(a)	3	3	1.15
1990 Local Community	2(a)	2.5	2.5	0.58
1990 Regulatory Authorities	2	2.5	2.75	0.96
1990 Academic/Research Institutions	1(a)	2.5	2.5	1.29
1990 NGOs	2	2	2.25	1.26
1990 Consumer Organisations	2	2	2.5	1
1990 British Potato Council	2	2.5	2.75	0.96
1990 Retailers Organisations	2	2	2.33	0.58

a Multiple modes exist. The smallest value is shown

Retailers reported that the most important influences on the way they managed their business with respect to fresh potatoes in both 1990 and 2000 were consumers, closely followed by partners in the supply chain, namely suppliers and growers. This confirms the findings from the literature review and the in-depth interviews that the key success factor in food retail sector is the satisfaction of consumers' demands, and thus, retailers need very close co-operation with their partners in the food supply chain in order to offer the food products consumers desire to purchase. Taking also into consideration the results from farmers' and merchants' survey, it can be concluded that there are strong interactions and influences between the participants of the supply chain, although, the dominant influence is from the consumer/retailer stage.

Other retailers are the next most important influence for both 1990 (median=3) and 2000 (median=3.5), reflecting the interaction of competition at the point of final sale. Government and regulatory authorities (1990 median=2.5, 2000 median=3), on average, were perceived to be of less than moderate influence on retailers during the last decade, which may reflect the fact that retailers have taken initiatives to promote their own and their partners' environmental and social business standards (e.g. crop protocols) above the legal requirements.

British Potato Council and research institutions were moderately important influences for both 1990 and 2000, indicating that they were valuable sources of information and knowledge to retailer. Local community was also important influence, because retailers drew customers and, to great extent, employees from it. The selected organisations were almost moderately important influences on retailers' decision making during the last decade, while business advisors were considered to be of little importance.

7.3.3. Importance of selected factors limiting potato business performance

Friedman test showed that there was no significant difference to the extent that the selected factors limited or constrained the performance of retailers' business with respect to potatoes in both 1990 and 2000 (Table 7.11). However, there was some

considerable difference in the means between the selected factors either for 1990 or for 2000, ranging, on average, from moderately limiting important (availability of technology and financial resources) to almost extremely (variability of potato price).

Table 7.10. Retailer perceptions of the importance of factors limiting the performance of potato business

	Retailer 1	Retailer 2	Retailer 3	Retailer 4
2000 Quality of Labour Force	3	5	3	5
2000 Relationships with Suppliers	2	4	5	4
2000 Relationships with Growers	2	4	5	3
2000 Information about Market Needs	2	4	5	4
2000 Financial Resources	2	4	2	4
2000 Variability of Potato Quality	2	4	5	5
2000 Availability of Potato Quantity	1	4	5	5
2000 Variability of Potato Price	2	2	5	5
2000 Availability of Technology	1	3	5	5
1990 Quality of Labour Force	3	5	2	4
1990 Relationships with Suppliers	4	5	4	4
1990 Relationships with Growers	3	4	5	4
1990 Information about Market Needs	4	2	3	4
1990 Financial Resources	3	3	2	4
1990 Variability of Potato Quality	4	4	4	4
1990 Availability of Potato Quantity	4	4	4	4
1990 Variability of Potato Price	4	5	5	5
1990 Availability of Technology	1	1	5	4

There was, on average, more convergence in retailers' responses about the limiting importance of the selected factors in 1990 than in 2000 (Tables 7.10 and 7.12). In fact, the standard deviation values for most of the selected factors were extremely high for 2000, indicating that retailers had few views in common.

Rather interestingly there was no significant difference to the extent that the selected factors limited or constrained the performance of retailers' business with respect to potatoes in both 1990 and 2000. Moreover, there was a huge variation of retailers' answers for the selected factors limiting importance in 2000 and, thus, there

was more convergence in responses in 1990 than in 2000, mainly, for relationships with suppliers and with growers, variability of potato quality and of price and availability of potato quantity. In fact, retailers claimed unanimously that variability of potato quality and availability of potato quantity (mode=4) were of considerable importance in 1990, while they almost unanimously said that variability of potato price (mode=5) was extremely important in 1990.

Table 7.11. Relative importance of factors limiting the performance of retailer potato business

Ranks based on Friedman Test				
	1990 Mean Rank	2000 Mean Rank	1990 Rank	2000 Rank
Quality of Labour Force	4.25	6.75	6	1
Relationships with Suppliers	6.13	5.00	2	3
Relationships with Growers	5.13	4.5	5	7
Information about Market Needs	4.13	5.00	7	3
Financial Resources	3	3.75	9	9
Variability of Potato Quality	5.38	6.00	3	2
Availability of Potato Quantity	5.38	5.00	3	3
Variability of Potato Price	8	4.88	1	6
Availability of Technology	3.63	4.13	8	8

Test Statistics[a]		
	1990	2000
N	4	4
Chi-Square	12.823	5.179
df	8	8
Asymp. Sig.	0.118	0.738
a Friedman Test		

7.4. Retailers' Self-Assessment on the Changes of the Performance of their Potato Business During 1990 and 2000

Descriptive and Frequencies statistics described in §5.4.1 were found useful to analyse retailers' self-assessment on the changes of the performance of their potato business during 1990 and 2000.

Table 7.12. Descriptive Statistics of the importance of factors limiting the performance of retailer potato business

	Mode	Median	Mean	Std. Deviation
2000 Quality of Labour Force	3(a)	4	4	1.15
2000 Relationships with Suppliers	4	4	3.75	1.26
2000 Relationships with Growers	2(a)	3.5	3.5	1.29
2000 Information about Market Needs	4	4	3.75	1.26
2000 Financial Resources	2(a)	3	3	1.15
2000 Variability of Potato Quality	5	4.5	4	1.41
2000 Availability of Potato Quantity	5	4.5	3.75	1.89
2000 Variability of Potato Price	2(a)	3.5	3.5	1.73
2000 Availability of Technology	5	4	3.5	1.91
1990 Quality of Labour Force	2(a)	3.5	3.5	1.29
1990 Relationships with Suppliers	4	4	4.25	0.5
1990 Relationships with Growers	4	4	4	0.82
1990 Information about Market Needs	4	3.5	3.25	0.96
1990 Financial Resources	3	3	3	0.82
1990 Variability of Potato Quality	4	4	4	0
1990 Availability of Potato Quantity	4	4	4	0
1990 Variability of Potato Price	5	5	4.75	0.5
1990 Availability of Technology	1	2.5	2.75	2.06

a Multiple modes exist. The smallest value is shown

The most important conclusion from retailers' self-assessment is that all of them mostly agree (mode=6 or 7) that their business performance with respect to fresh potatoes has improved according to most of the selected indicators over the last 10 years. However, though two of the retailers either 'mostly' or 'totally' agreed that their business overall profitability has improved, another 'totally' disagreed and the other one preferred not to reply to this question (Tables 7.13 and 7.14).

Retailers mostly agreed that reducing environmental risk brings financial benefits to their business (median and mode=6), financial benefits exceed costs from skills improvement (median and mode=6), improving employees' skills benefits environment (median=5.5 and mode=5).

Two of the retailer were rather negative (mostly disagreed) about the potential that organic potatoes can bring both environmental and financial benefits either to their business or to the whole supply chain, while the other two retailers were more positive

as they 'mostly' or 'slightly' agreed. However, all retailers 'mostly' or 'totally' agreed that deregulation had been a good thing for the potato industry.

Table 7.13. Retailer perceptions of the changes of the performance of their potato business during 1990 and 2000 and opinions on the trade-offs between sustainability element

	Retailer 1	Retailer 2	Retailer 3	Retailer 4
Output Per Worker Increased	6	7	6	6
Relationships with Suppliers Improved	7	7	7	6
Relationships with Growers Improved	6	7	6	5
Relationships with Employees Improved	6	7	5	5
Relationships with Local Community Improved	6	5	4	6
Services Offered Improved	7	7	7	6
Potatoes are of Higher Quality	7	7	7	6
Knowledge of Market Needs Improved	6	6	7	6
Use of IT Increased	7	6	7	7
Overall Profitability Improved	6	2	7	No Value
Natural Resources Management Improved	6	5	6	7
Environmental Pollution Risk Reduced	6	6	7	7
Employees Skills Improved	6	6	6	7
Reducing Environmental Risk Brings Financial Benefits	6	4	7	6
Financial Benefits Exceed Costs from Skills Improvement	6	6	5	6
Improving Skills Benefits Environment	6	5	5	7
Organic Have Environmental AND Financial Benefits for MY BUSINESS	6	2	5	2
Organic Have Environmental AND Financial Benefits for WHOLE SC	6	2	5	3
Deregulation Has Been a Good Thing	6	7	7	No Value

Table 7.14. Descriptive Statistics of retailers' self-assessment on the changes of the performance of their potato business during 1990 and 2000 and opinions on the trade-offs between sustainability elements

	Mode	Median	Mean	Std. Deviation
Output Per Worker Increased	6	6	6.25	0.5
Relationships with Suppliers/Packers Improved	7	7	6.75	0.5
Relationships with Growers Improved	6	6	6	0.82
Relationships with Employees Improved	5	5.5	5.75	0.96
Relationships with Local Community Improved	6	5.5	5.25	0.96
Services Offered Improved	7	7	6.75	0.5
Potatoes are of Higher Quality	7	7	6.75	0.5
Knowledge of Market Needs Improved	6	6	6.25	0.5
Use of IT Increased	7	7	6.75	0.5
Overall Profitability Improved	2(a)	6	5	2.65
Natural Resources Management Improved	6	6	6	0.82
Environmental Pollution Risk Reduced	6(a)	6.5	6.5	0.58
Employees Skills Improved	6	6	6.25	0.5
Reducing Environmental Risk Brings Financial Benefits	6	6	5.75	1.26
Financial Benefits Exceed Costs from Skills Improvement	6	6	5.75	0.5
Improving Skills Benefits Environment	5	5.5	5.75	0.96
Organic Have Environmental AND Financial Benefits for MY BUSINESS	2	3.5	3.75	2.06
Organic Have Environmental AND Financial Benefits for WHOLE SC	2(a)	4	4	1.83
Deregulation Has Been a Good Thing	7	7	6.67	0.58
a Multiple modes exist. The smallest value is shown				

7.5. Relative Importance of Economic, Environmental and Social Objectives on Retailers' Choice for Supply Chain Systems

Conjoint analysis aimed to explore the relative importance of economic, environmental and social performance on the way retailers choose fresh supply chain (growers-supplier-retailer) potato systems. The SPSS Conjoint procedure has been used to analyse the data derived from the 4 questionnaires with valid answers. Friedman and Wilcoxon Signed Ranks tests were also used (described in §5.7.2). The individual

results for each retailer are presented because the results are not statistically based but rather must be seen as case study examples. Pearson's R correlation coefficients for each individual respondent ranged between 0.907 and 0.973, showing that retailers were consistent to their preferences (Table 7.15).

Table 7.15. Retailers' individual conjoint results

	Retailer 1	Retailer 2	Retailer 3	Retailer 4
Constant	**5**	**5**	**5.2222**	**4.4444**
Part-worth Evaluation of Low Economic Performance	-1.2857	-1.4762	-1.6667	-1.9524
Part-worth Evaluation of Medium Economic Performance	-0.7143	0.8095	-0.6667	0.619
Part-worth Evaluation of High Economic Performance	2	0.6667	2.3333	1.3333
Importance (%) of Economic Performance	**60.53**	**23.88**	**42.86**	**51.11**
Part-worth Evaluation of Low Environmental Performance	-0.3333	-1.6667	-1.8889	-0.4444
Part-worth Evaluation of Medium Environmental Performance	0.2381	-0.381	-0.2222	0.4603
Part-worth Evaluation of High Environmental Performance	0.0952	2.0476	2.1111	-0.0159
Importance (%) of Environmental Performance	**10.53**	**38.81**	**42.86**	**14.07**
Part-worth Evaluation of Low Social Performance	-0.9048	-2.2857	-0.5556	-1.3492
Part-worth Evaluation of Medium Social Performance	0.6667	1	-0.2222	0.8889
Part-worth Evaluation of High Social Performance	0.2381	1.2857	0.7778	0.4603
Importance (%) of Social Performance	**28.95**	**37.31**	**14.29**	**34.81**
Pearson's R	**0.941**	**0.973**	**0.915**	**0.907**

There is variation on retailers' perceptions about the relative importance of each performance, which could be attributed, among other reasons, to perceptions of the individual representative respondents. However, retailers are clearly very concerned that a low performance on either economic, environmental or social performance is unacceptable, although they showed preference for some criteria more than others. Two

of the retailers consider mainly economic performance (more than 50%) when their business make decisions about the supply chain system, followed by social performance (around 30%) and, to a much lesser extent, environmental performance (less than 14%) . High economic performance is also considerably preferred to medium. Rather interestingly, their businesses preferred medium environmental and social performances to high ones (Table 7.15). It seems that the perceived good improvements of their businesses (according to self-assessment) in all aspects of environmental and social performance in the last 10 years were mainly compliance driven in response to pressures from outside.

One retailer claimed to take into account equally mainly environmental and social performance, considerably more than economic. This retailer was indifferent between medium and high economic and social performances, but high environmental performance was preferred to medium. Another retailer believed that both economic and environmental performances are equally important and much more so than social criteria. This retailer showed much greater preference for high compared to medium economic, environmental and social performances.

Table 7.16. The relative importance of attributes on retailer choice of supply chain systems (Friedman Test)

Ranks	
	Mean Rank
Importance (%) of Economic Performance	2.38
Importance (%) of Environmental Performance	1.88
Importance (%) of Social Performance	1.75

Test Statistics(a)	
N	4
Chi-Square	0.933
df	2
Asymp. Sig.	0.627
a Friedman Test	

Friedman and Wilcoxon Signed Ranks tests also found that none of the performances was significantly more important than the others on the way retailers choose supply chain systems (Tables 7.16 and 7.17). This can be attributed to the small size of the sample, as well as to the great dispersion of values for each performance (Table 7.15).

Table 7.17. The relative importance of attributes on retailer choice of supply chain systems (Wilcoxon Signed Ranks Test)

Test Statistics(c)			
	Importance (%) of Environmental Performance - Importance (%) of Economic Performance	**Importance (%) of Social Performance - Importance (%) of Economic Performance**	**Importance (%) of Social Performance - Importance (%) of Environmental Performance**
Z	-1.069(a)	-1.461(a)	.000(b)
Asymp. Sig. (2-tailed)	.285	.144	1.000
a Based on positive ranks.			
b The sum of negative ranks equals the sum of positive ranks.			
c Wilcoxon Signed Ranks Test			

7.6. Summary of Chapter

Food product safety and quality were declared to be unanimously of extreme importance in retailers' decision making in 2000, followed closely by other selected market and economic related factors. Such factors were also the most important in 1990. Environmental and social related factors were considered the least important for both 1990 and 2000. These results confirm the findings of the literature review and the in-depth interviews that changes in the food supply chain during the last decade resulted to the dominance of market and economic related factors in retailer' decisions management.

Consumers were reported to be the most important influence on retailers, and in particular they were almost unanimously extremely important in 2000. Retailers'

partners in the supply chain were the next most important for both 1990 and 2000, followed by other retailers. All other groups or organisations were moderately (median= 2 to 3) important during the last decade, while business advisors were of little importance between. Thus, taking into consideration findings from previous parts of the survey it becomes clear that the participants of the supply chain strongly influence, and are influenced by, each other.

There was no significant difference to the extent that the selected factors limited or constrained the performance of retailers' business with respect to potatoes in both 1990 and 2000. All retailers claimed that the great majority of the selected factors were important constraints (mode=4 or 5) on their business performance with respect to fresh potatoes in both 1990 and 2000, except one retailer who claimed that almost all factors were either 'little' or 'not at all' limiting in 2000. Thus, retailers seem to perceive that most of the selected limiting factors are areas where they could improve their business performance in the future.

Retailers perceive that their business performance had mostly improved in terms of all sustainability aspects, except one retailer that 'totally' disagreed that his business profitability had improved. Moreover, retailers are rather positive that there is 'win-win' relationship between economic, environmental and social improvement. These findings are very important for the sustainability of the fresh potato supply chain. They are also, on average, not convinced that organic potatoes can bring both economic and environmental benefits, but they are rather positive about the benefits of deregulation. According to the in-depth interviews, retailers' negative stance for organic potatoes could be attributed to the difficulties in sourcing and marketing adequate and uniform organic supplies throughout the year at 'reasonable' prices. However, organics help retailers to build the good image of their company.

Conjoint analysis revealed that two of the retailers considered mainly economic performance, placing little importance on environmental performance and moderate importance on social for their business. For another retailer environmental and social performances were equally the most important, and economic performance was of moderate importance. The other retailer emphasized both economic and environmental performances, while social was perceived to be relatively unimportant. However, none

of the performances was statistically significantly more important than the others, which can be attributed to the small size of the sample, as well as to the great variation of the relative importance of each performance among retailers.

In all cases negative economic or environmental or social performance was very undesirable for retailers. Moreover, on average, it was very important to them to achieve maximum and consistent financial returns. Moreover, high environmental performance was considerably preferred to medium. However, they were indifferent between medium and high social performance. These findings also show that retailers probably perceive that environmental and social factors are linked to economic performance, for example, through market differentiation and building their company's good image.

Finally, it should be mentioned that the findings of the retailer survey reflect the perceptions of individual respondents within the organizations and not necessarily the collective or indeed agreed corporate views.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1. Introduction

This chapter deals initially with an overview of the aim and objectives of the study, followed by the approach used to address them. The conclusions and recommendations emerging from the research are also reported.

8.2. Summary of Aim, Objectives and Approach

The fresh vegetables supply chain plays a very significant role in the welfare of British society by producing and distributing food products of required quantities and qualities. Sustainable development is also an issue of increasing importance at both national and international level. However, the links between fresh vegetables supply chain and sustainability (economic, environmental and social aspects) are not well understood. In this context, the present study was undertaken with the broad aim of developing and applying a framework for assessing the sustainability of fresh vegetables chain over time, focusing on the sustainability of potatoes during the last decade as an example.

Four research questions - objectives were used to guide the study:

- Question 1. Is it possible to measure the sustainability of the fresh vegetables supply chain? If yes, what are the relevant quantitative and qualitative measurements to assess sustainability, and in particular of the fresh potato supply chain?
- Question 2. What has been the change in the performance of fresh potato supply chain during the last decade according to the relevant quantitative and qualitative sustainability measurements?

- Question 3. What factors have influenced the changes in the performance of fresh potato supply chain in terms of sustainability during the last decade?
- Question 4. What actions can be taken to improve the sustainability of the fresh potato supply chain in the next decade and by whom?

Following these research questions an approach, based on extensive literature review and on in-depth semi-structured interviews, was developed and applied to assess the sustainability of the fresh potato chain during the last decade. A quantitative survey was carried out to assess the performance of fresh potato supply chain according to selected economic, environmental and social indicators in an objective manner. The perceptions of the sustainability of potato business activities were also elicited from participants in the supply chain by questionnaire (qualitative survey).

Research question 1 was answered by literature review and in-depth interviews with key representatives from all stages of the supply chain. The concepts of sustainable development, supply chain management, fresh vegetables supply chain and sustainability assessment of supply chain were used in this process. The Driver-Pressure-State-Impact-Response framework of EEA was also chosen as conceptual framework to assess the sustainability of fresh potato supply chain. Research question 2 was partially covered by a quantitative survey using an integrated set of sustainability indicators in an objective manner. However the significant lack of data prevented the quantitative survey from providing a complete assessment of the changes on the performance of fresh potato supply chain in the last 10 years. Important information on research question 2 derived from a qualitative survey of participants' perceptions on the changes of their business performance during the last decade.

Research question 3 was answered by a qualitative survey of the perceptions of the participants in the food supply chain for the importance of factors influencing supply chain performance during the last decade. These were elicited by three groups of questions which dealt with participants' attitudes to their business sustainability, the influence of other people and organisations influencing participants' decision making, and factors limiting business performance. In addition, conjoint analysis was used to identify the relative importance of economic, environmental and social performance in

participants' decisions making with respect of managing their businesses. The questionnaire was sent to 1000 farmers with relatively large potato enterprises, 240 of which responded, to 28 merchants that supply fresh potatoes to major retailers, 17 of which responded, and to 8 major retailers, 4 of which replied.

Research question 4 was partially covered by the qualitative survey and partially by the in-depth semi-structured interviews with representatives of all stages of the fresh potato supply chain.

The study was assisted through the discussion of the research methods and results as the study progressed with several farmers, marketing and buying managers at merchant and retail stages, and specialists through personal interviews and discussion at conferences.

8.3. Conclusions

The overall conclusions emerging from the present study can be summarised as follows:

The relevant quantitative and qualitative measurements to assess the sustainability of fresh vegetables, and in particular of fresh potato, supply chain (Question 1)

An approach was developed to assess the sustainability of fresh potato supply chain combining the findings of the relevant literature and interviews with key representatives of the supply chain. The approach was applied in the fresh potato supply chain after being refined by further discussions with participants in the supply chain and specialists on relevant issues.

The Driver-Pressure-State-Impact-Response framework of EEA was chosen as conceptual framework to assess the sustainability of fresh potato supply chain. Thirteen economic, environmental and social indicators were selected to quantitatively assess the supply chain performance over time in an objective manner (quantitative survey). The qualitative survey also asked respondents to self-assess the changes in their business performance over last 10 years with respect to thirteen sustainability criteria. The

qualitative survey also elicited respondents' perceptions on the importance of selected factors influencing the sustainability of their business.

The change in the sustainability of the fresh potato supply chain during the last decade (Question 2)

The quantitative survey could not help to assess the change in the performance of fresh potato supply chain during the last decade, because although there were enough data to assess the performance at farmer and merchant stage in 2000, there was significant lack of data at retailer stage. Moreover, complete performance data were not available for 1990.

The qualitative survey concluded that respondents perceive that their business performance has changed significantly with respect to the selected sustainability criteria (Table 8.1). In particular, farmers' assessment of the change in their potato enterprise performance during the last decade revealed that although they perceive that production efficiency and environmental and social performance significantly improved, profitability decreased and thus they drew less satisfaction from their business than 10 years ago. This confirms the findings from the literature review that the profit margins of potato production are perceived to have been squeezed and environmental and social performance to have improved, although there is great variation in the performance among potato enterprises.

Merchants' assessment also showed that in general almost all of them perceive that their potato business performance has improved in terms of most of the selected sustainability criteria during the last decade. However, on average, they believe that profitability remained almost the same as 10 years ago.

Retailer representatives perceive that their business performance had mostly improved in terms of all sustainability aspects, except one who considered that business profitability had not improved.

Farmers, merchants and retailers perceptions on the changes of their business performance coincide to great extent, however, retailer representatives reported higher

improvement in their relationships with local community and overall profitability, except one representative who mentioned that business profitability had not improved. These results agree with the literature review and the in-depth interviews, which showed that fresh potato supply chain is perceived to be more sustainable in terms of environmental and social criteria than 10 years ago, although, it is likely that participants perceptions reflect, to some extent, optimistic and strategic bias. Moreover, the findings from the merchant and retailer surveys reflect the perceptions of individual respondents within the organizations and not necessarily the collective or indeed agreed corporate views. However, there are no recorded objectively verified sources to confirm the reliability of the findings from the respondents' assessment on the changes of the performance of the supply chain in the last 10 years, with the exception of records from surveys of potato farmers.

Table 8.1. Respondents' assessment (mode of answers) of the changes on their business performance during 1990-2000

	Farmers	Merchants	Retailers
Output Per Worker Increased	7	6	6
Relationships with Farmers Improved		6	6
Relationships with Merchants Improved	6		7
Relationships with Retailer Improved	4	6	
Relationships with Employees Improved	6	6	5
Relationships with Local Community Improved	4	4	6
Potatoes are of Higher Quality	6	7	7
Being Producer More Satisfying	4		
Services Offered Improved		7	7
Knowledge of Market Needs Improved	6	6	6
Use of IT Increased	6	7	7
Overall Profitability Improved	4	4	2(a)
Land & Soil Management Improved	6		
Irrigation Management Improved	7		
Natural Resources Management Improved		6	6
Environmental Pollution Risk Reduced	6	7	6(a)
Employees Skills Improved	6	6	6
a Multiple modes exist. The smallest value is shown			
A 7 points Likert-type scale was used for this question. Respondents had the option to disagree totally (1), mostly (2) and slightly (3), neither disagree nor agree (4), and agree slightly (5), mostly (6) and totally (7).			

The perceptions of the participants of the importance of factors influencing fresh potato supply chain performance during the last decade (Question 3)

The most important conclusion from the farmers' questionnaire survey was that their main concern is to remain in business and while environmental and social issues were significantly more important in 2000 than they used to be in 1990, profitability was and is the dominant factor in their decision making. Thus, farmers perceived that financial and market related factors are the most important factors in their decision making about their potato enterprise (Table 8.2). Hence, it was not surprising the main influences on farmers during the last decade were people or organisations directly involved in the food supply chain (Table 8.3). Moreover, they claimed that financial and market related factors act as greater constraint on their enterprise performance than environmental and social related factors (Table 8.4).

Table 8.2. The 3 most important factors influencing farmer, merchant and retailer decisions on potato enterprise or business management

	Farmer		Merchant		Retailer	
	1990 Rank	2000 Rank	1990 Rank	2000 Rank	1990 Rank	2000 Rank
Profitability	1	1	1	1	1	5
Land and Soil Quality	2	4				
Relationships with SC	7	3	2	5	4	3
Market Requirements	4	2				
Use of New Technologies	3	10				
Environmental Risk			9	3		
Business Uncertainty			3	6		
Food Product Safety and Quality			5	2	3	1
Market Requirements					2	2
Ranks based on Friedman Test						

Merchants' perceived that staying in business nowadays is a much more complicated task than it was 10 years ago. Although profitability remained the most

important factor in merchants' management decisions, it was closely followed in importance by other market, environmental and social related criteria (Table 8.2). Merchants also perceived to be mainly influenced by groups or organisations directly involved in the food supply chain, including regulatory authorities (Table 8.3). Merchants perceived also that profitability and market related factors are those that limit and simultaneously define the performance of their potato business (Table 8.4).

Table 8.3. The 3 most important groups or organisations influencing farmer, merchant and retailer decisions on potato enterprise or business management

	Farmer		Merchant		Retailer	
	1990 Rank	2000 Rank	1990 Rank	2000 Rank	1990 Rank	2000 Rank
Farmers			2	2	2	2
Merchants	1	1			3	2
Retailers	2	3	1	1		
Consumers	3	2	3	3	1	1
Ranks based on Friedman Test						

Table 8.4. The 3 most important factors limiting the performance of farmer, merchant and retailer potato enterprise or business

	Farmer		Merchant		Retailer	
	1990 Rank	2000 Rank	1990 Rank	2000 Rank	1990 Rank	2000 Rank
Land and Soil Quality	2	3				
Variability of Potato Quality	3	2	2	1	3	2
Variability of Potato Price	1	1	3	3	1	6
Relationships with Retailers			1	2		
Quality of Labour Force					6	1
Relationships with Suppliers					2	3
Information about Market Needs					7	3
Availability of Potato Quantity					3	3
Ranks based on Friedman Test						

Food product safety and quality were declared to be unanimously of extreme importance in retailers' decision making in 2000, followed closely by other selected

market and economic related factors (Table 8.2). Such factors were also the most important in 1990. Environmental and social related factors were considered the least important for both 1990 and 2000. Consumers were reported to be the most important influence on retailers, and in particular they were almost unanimously extremely important in 2000 (Table 8.3). Retailers' partners in the supply chain were the next most important for both 1990 and 2000. All retailers claimed that the great majority of the limiting factors were important constraints on their business performance with respect to fresh potatoes in both 1990 and 2000 (Table 8.4).

Conjoint analysis revealed that the most important element of sustainability (economic, environmental and social performance) on the way farmers, merchants and retailers choose potato production or supply chain systems is economic performance. The relative importance placed on economic objectives is, on average, more than 40% compared to environmental and social performance which each accounted for around 30% (Table 8.5). Economic performance was significantly a more important criterion on farmers' preference for potato production systems than environmental and social performance. However, none of the performances was statistically significantly more important than the others for merchants and retailers, which can be attributed to the small size of the sample of merchants and retailers, as well as to the great variation of the relative importance of each performance among respondents.

Table 8.5. Relative importance of sustainability criteria (mean values) on farmer, merchant and retailer preferences for production or supply chain systems

	Farmers	Merchants	Retailers
Importance (%) of Economic Performance	42	40	45
Importance (%) of Environmental Performance	28	32	27
Importance (%) of Social Performance	30	29	29

Farmers, merchants and retailers perceive themselves to be committed to achieve high performance in terms of economic, environmental and social aspects in their potato business. All respondents also claimed that they had strong desire to avoid

possible negative economic, environmental or social performance. Moreover, it was very important for them to achieve high and reliable financial returns. However, farmers and merchants seemed to be reluctant to demonstrate very strong commitment to a high level of environmental protection and improvement if this means compromising economic performance. Farmers and merchants did not perceive that reducing environmental risk could bring significant financial benefits to their business. Retailers considerably preferred high to medium environmental performance, but they were indifferent between medium and high social performance. These findings are probably due to retailers' perceptions, in contrast to farmers and merchants, that environmental and social factors are positively linked to economic performance, because retailers are concerned to protect their corporate reputations.

The actions that can be taken to improve the sustainability of fresh vegetables supply in the next decade (Question 4)

Farmers believe that they will face stronger competition in future because of globalisation of food markets. However, they also think that the majority of British potatoes will be produced under farm assurance schemes. Thus farmers feel that in addition to securing satisfactory profitability, they will be required to improve their environmental and social performance.

Merchants mentioned that the benefits of cost reduction from the production and marketing of fresh potatoes should be divided proportionally between the actors of all stages of the supply chain. Farmers and merchants also suggested that public or private bodies should better inform consumers about the effort, money, time and resources committed to producing the quality criteria demanded by consumers. For example, considerable expense, energy and water are used to irrigate potatoes, to produce fresh potatoes with unblemished skins and uniform appearance, in spite of the fact that most potatoes are eventually peeled before consumption.

Both merchants and farmers, in the in-depth interviews, suggested that there should be more collaboration among themselves and major retailers in order to reduce

the degree of business uncertainty in the fresh potato supply chain, for the benefit of all participants.

Overall conclusions

This study demonstrated that it is possible to develop and apply an approach to assess the performance of fresh vegetables supply chain over time according to economic, environmental and social indicators, and that it is also feasible to identify the relevant factors and assess their relative importance on influencing the supply chain performance.

The developed approach of fresh vegetables supply chain sustainability assessment consists of semi-structured in-depth interviews; quantitative economic, environmental and social indicators; and questionnaire surveys to elicit participants' perceptions of the factors that influence the sustainability of their business and on the changes of their sustainable business performance. The lack of adequate data at the quantitative survey prevented a complete objective measurement of the sustainability of the supply chain. However, considering the time, budget and data collection limitations, the developed approach addressed the aim of the study, namely the assessment of the degree of sustainability of fresh potato supply chain and factors which have influenced it.

The results from this study need to be treated with caution. Respondents' perceptions and recall about the factors that influence the sustainability of their potato business may be subject to optimistic and strategic bias, but wherever possible attempts were made to minimize this.

8.4. Recommendations

The recommendations emerging from the study are as follows:

It is recommended that the British Potato Council or an industry consortium brings together a panel of experts and representatives from all stages of the supply chain to discuss the findings of this survey and explore the ways to overcome some issues raised about the fresh potato supply chain and its sustainability. This study has chosen a set of economic, environmental and social indicators to assess the sustainability of the supply chain. It would be useful to agree a set of key indicators to measure and monitor the trends of the sustainability of the supply chain over time.

The participants of all stages mentioned that profitability is the most important factor in their decisions on their business management, however, farmers and merchants perceived that the profitability of their business has been stable or declined over the last decade and thus farmers drew less satisfaction from their business than 10 years ago. This could be an issue for further discussion by the panel. The merchants and farmers suggested of more collaboration among themselves and major retailers in order to reduce the degree of business uncertainty in the fresh potato supply chain, for the benefit of all participants. Identifying other ways to improve the sustainability of the supply chain would be an important outcome of such a panel.

The survey revealed that all farmers, merchants and retailers perceive that consumers are the most important influence on the fresh potato supply chain because they are the end users of the product. This survey focused mainly on the perceptions of the participants in the supply chain. Considering the findings of the in-depth interviews that consumers perceive to be insufficiently informed by the participants on the supply chain, it would relevant to develop and apply an approach to assess the sustainability of the supply chain from the consumer point of view. Such research would help to identify consumers' perceptions about the sustainability of the fresh produce supply chain and the extent that consumers' and participants' perceptions coincide about the sustainability of the supply chain.

The participants in the supply chain or governmental agencies should also better inform consumers about the implications on the sustainability of fresh food supply chain of their requirements for continuous supply all over the year and the quality criteria to be met, especially in terms of the product appearance. Participants in the

supply chain mentioned that aspects of their business performance could potentially improve if consumers were not so demanding on aspects such as product appearance.

The quantitative survey did not provide a measurement of the changes in the fresh potato supply chain performance during the last decade because of the lack of adequate data, especially in 1990. However, the assessment of the supply chain performance according to the selected sustainability indicators is more complete for 2000. Therefore, it is recommended that this analytical framework is further developed and applied in the fresh potato supply chain on a regular basis in the future by supply chain participants or governmental agencies. Considering the importance of the consumer stage in the sustainability of the fresh potato supply chain, it is recommended that this stage (food preparation for example) is included in the further developed analytical framework in order to get complete picture. This would set the supply chain performance of 2000 as a 'baseline' for benchmark, provided that the confidentiality issues, which prevented the complete application of the approach, could be overcome. This could provide an ongoing monitoring and evaluation of the changes in the supply chain performance in an objective manner. It is also recommended that drawing on the approach developed here qualitative surveys are carried out at the same time in order to monitor the changes in supply chain participants' perceptions about the sustainability of their industry. The response ratios of the merchant and retailer qualitative surveys of this study were relatively high. However, considering the small number of merchants and particularly of retailers, it is recommended for the future studies that personal visits be made to merchant and retailer representatives, if feasible, to confirm and refine the findings of the survey.

Almost all the sustainability indicators and the factors that influence sustainability selected for the qualitative survey are constructs consisting of several components. This helped to combine and make manageable several sustainability aspects in the qualitative survey. However, it could be argued that this is concealing the variation in understanding by participants of aspects such as 'business uncertainty' or 'relationships with the rest of the supply chain'. A more detailed study could identify the detailed components that make up sustainability aspects of the supply chain and

what is the relative importance of each component. Such research could help to better identify the actions to improve the sustainable performance of the supply chain.

The study revealed the importance of relationships, trust and shared values, norms of behaviour, adoption of good practices and duty of care amongst the participants in the fresh produce supply chain. This could be perceived as the social capital, an important element of sustainability, of the supply chain and it is relevant topic for further study.

This study focused on the British fresh potato supply chain. The approach, however, could be used to assess the sustainability in different supply chains of fresh vegetables, provided that the confidentiality issues that prevented the complete application of the approach can be overcome. The framework for the quantitative assessment consists of an integrated set of sustainability indicators for the supply chain and can be used as a basis for certification from the main players that their activities demonstrate a degree of sustainability. It can also be used by public agencies in order to assess the degree of sustainability of the various production, distribution and retailing systems and find out how the government should better intervene into the market. The questionnaire developed in the qualitative survey could also be used to assess sustainability in different supply chains of fresh vegetables, although it is likely that some amendments should be made to suit particular supply chains.

The Conjoint Analysis question showed the relative importance of economic, environmental and social performance placed by farmers, merchants and retailers on the way they chose production or supply chain systems. However, it is recommended this particular question to be sent separately from the rest questionnaire and to the whole sample, because the respondents faced difficulties it filling in. Other methods such as Delphi method could also be used to explore the relative importance of economic, environmental and social performance on participants' decision making.

The literature review revealed that there is some debate among those involved directly or indirectly in the fresh food supply chain about the benefits from the application of farm assurance schemes. The developed approach could be used to explore whether the introduction of farm assurance schemes has resulted in improving

the sustainability of fresh potato supply chain. The various participants on the supply chain including consumers and regulatory agencies should be more involved in setting the standards, defining criteria for assurance, and promoting the adoption of these schemes. In this way these schemes can be 'owned' and understood by all the participants in the supply chain. In particular, consumers will be better informed about the characteristics and potential benefits of farm assurance schemes. The in-depth interviews revealed that consumers are not sufficiently informed about the initiatives taken to improve the performance of the fresh food supply chain in terms of sustainability.

Organic potato production appears to be unattractive to the majority of farmers, merchants and retailers. Agents interested or involved in the production and marketing of organic products should identify the reasons behind participants' negative attitude. The participants in this survey did not perceive that improving environmental performance (perceived as one of the key benefits of organic produce) could simultaneously bring financial benefits to their business or to the whole supply chain. According to the in-depth interviews, retailers' negative attitude to organic potatoes could also be attributed to the difficulties in sourcing and marketing adequate and uniform organic supplies throughout the year at 'reasonable' prices. If these perceptions are confirmed by further research, then it would be obvious that organic produce would need more public support than that provided so far, because although organics may help retailers to build the good image of their company, the other participants in the supply chain seem reluctant to bear the business uncertainty of financial loses involved in producing and marketing organic potatoes.

Deregulation in the fresh potato supply chain seems to have benefited the producers of larger potato enterprises more than smaller. The impacts of deregulation on producers of smaller enterprises could also be a relevant topic for further research because these producers are an integrated part of rural society and economy and their well-being is an important aspect of rural development.

8.5. Closing Statement

This exploratory study has for the most part achieved what it set out to do. The research confirmed the importance of assessing the sustainability of fresh potato supply chain and concluded that it is a valid topic for further research. The developed approach is also recommended to be used to assess the sustainability of other fresh vegetable supply chains.

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APPENDICES

APPENDIX 1

QUESTIONNAIRES OF THE IN-DEPTH SEMI-STRUCTURED INTERVIEWS

Questions discussed with farmers at the in-depth semi-structured interviews

- What are the main characteristics of your potato enterprise production and marketing?
- What kind of information do you keep about field activities and applications of inputs?
- What is the way fresh potatoes get to arrive to consumers? What are the relationships of players in supply chain?
- What are the most important factors and issues that influence potato production and marketing?
- What is the relative importance of the above mentioned factors in your decision making? What other factors influence your decision making?
- What are the drivers for changes in the supply chain? What is the relative importance of these drivers?
- What are the main changes that have taken place in the potato supply chain in the last 10-15 years? How have these changes affected the potato production and marketing?
- Are there other issues of particular concern at this moment or in the future?

Questions discussed with merchant representatives at the in-depth semi-structured interviews

- What are the main characteristics of your business in terms of procuring, prepacking and marketing fresh potatoes?

- What kind of information do you (you or other actors in the supply chain on your behalf) keep about activities and applications of inputs (when potatoes arrive to you or even before)?

- What is the way fresh potatoes get to arrive to consumers? What are the relationships of players in supply chain?

- What are the most important factors and issues that influence your decision making in terms of procuring, prepacking and marketing fresh potatoes?

- What is the relative importance of the above mentioned factors in your decision making? What other factors influence your decision making?

- What are the drivers for changes in the supply chain? What is the relative importance of these drivers?

- What are the main changes that have taken place in the potato supply chain in the last 10-15 years? How have these changes affected the procurement, prepacking and marketing of fresh potatoes?

- Are there other issues of particular concern at this moment or in the future (globalisation, organic foods, GMOs)?

Questions discussed with retailer representative at the in-depth semi-structured interview

- What are the main characteristics of retailing and marketing fresh vegetables and especially potatoes?

- What kind of information do you (you or other actors in the supply chain on your behalf) keep about activities and applications of inputs (when potatoes arrive to you or even before)?

- What is the way fresh potatoes get to arrive to consumers? What are the relationships of players in supply chain?

- What are the most important factors and issues that influence your decision making in terms of procuring and marketing fresh potatoes?

- What is the relative importance of the above mentioned factors in your decision making? What other factors influence your decision making?

- What are the drivers for changes in the supply chain? What is the relative importance of these drivers?

- What are the main changes that have taken place in the potato supply chain in the last 10-15 years? How have these changes affected the procurement and marketing of fresh potatoes?

- Are there other issues of particular concern at this moment or in the future (globalisation, organic foods, GMOs)?

Questions discussed with consumers at the in-depth semi-structured interviews

- How often do you buy potatoes? How important are potatoes for your diet?

- Where do you buy potatoes? What are the reasons for these choices?

- What are the most important factors and issues that influence your decisions when buying potatoes in general?

- What is the relative importance of the above mentioned factors in your decision making?

- What are your resources of information for issues related with fresh potatoes and sustainable development?

- How important are the environmental and health and safety issues (for those that produce and market potatoes) in your decision making?

- Are there any changes in your choices for potatoes buying in the last 10-15 years? What are the reasons (drivers) for these changes?

- Are there other issues of particular concern at this moment or in the future?

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APPENDIX 2

FARMERS' QUESTIONNAIRE

1st Phase of Farmers' Questionnaire

Dear Sir,

RE: Performance of the Supply Chain for Fresh Potatoes

Cranfield University at Silsoe is offering you the **chance to win a valuable prize** for growers once you complete and return the attached questionnaire on potato production. All completed questionnaires will be entered into a PRIZE DRAW, the prize for which is a specialist consultation for your farm valued at £1000 on some aspect of land, business or marketing management from our leading national experts on these subject.

With the help of the **British Potato Council**, Cranfield University at Silsoe is researching the factors which influence the management of the supply chain for potatoes and how these may have changed over the last ten years.

The attached questionnaire is designed to capture the views of growers like yourself for this important research. The findings of the enquiry will help us to understand the pressures on the industry and how the industry has responded to these. Linked with other research, it will help to identify actions which can help to secure a sustainable and rewarding future for those who work within it.

Similar types of questions are being sent to a sample of packers and retailers in the potato supply chain, so it is important that growers' views are fully represented. All responses will be treated in absolute confidence.

Please return the completed questionnaire in the pre-paid envelope by February 14th 2001.

If you have any queries about this survey, please do not hesitate to contact me at the above address, by telephone or e-mail. If you wish to receive a summary of the findings, please indicate this on the questionnaire and these results will be sent to you when available

Many thanks for helping in this important research which will be of considerable benefit to the industry,

Yours sincerely

Joe Morris

Professor, Resource Economics and Management

Cranfield UNIVERSITY Silsoe

1. At the present time, how important are the following factors in your management decisions for your potato enterprise? Please place a tick in the box for the alternative that best reflects your feeling.

Factors	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Profitability	[ ]	[ ]	[ ]	[ ]	[ ]
Climate	[ ]	[ ]	[ ]	[ ]	[ ]
Land and soil quality	[ ]	[ ]	[ ]	[ ]	[ ]
Water for irrigation	[ ]	[ ]	[ ]	[ ]	[ ]
Environmental risk (e.g. associated with fertiliser and pesticides use)	[ ]	[ ]	[ ]	[ ]	[ ]
Personnel management	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with the rest of supply chain (e.g. with merchants/packers and retailers)	[ ]	[ ]	[ ]	[ ]	[ ]
Business Uncertainty	[ ]	[ ]	[ ]	[ ]	[ ]
Market requirements (e.g. product specification)	[ ]	[ ]	[ ]	[ ]	[ ]
Food product safety and quality	[ ]	[ ]	[ ]	[ ]	[ ]
Community and local interests	[ ]	[ ]	[ ]	[ ]	[ ]
Use of new technologies (e.g. varieties, mechanisation)	[ ]	[ ]	[ ]	[ ]	[ ]

2. 10 years ago, i.e. in 1990, how important were the following factors in your management decisions for your potato enterprise? Please place a tick in the box for the alternative that best reflects your feeling.

Factors	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Profitability	[ ]	[ ]	[ ]	[ ]	[ ]
Climate	[ ]	[ ]	[ ]	[ ]	[ ]
Land and soil quality	[ ]	[ ]	[ ]	[ ]	[ ]
Water for irrigation	[ ]	[ ]	[ ]	[ ]	[ ]
Environmental risk (e.g. associated with fertiliser and pesticides use)	[ ]	[ ]	[ ]	[ ]	[ ]
Personnel management	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with the rest of supply chain (e.g. with merchants/packers and retailers)	[ ]	[ ]	[ ]	[ ]	[ ]
Business Uncertainty	[ ]	[ ]	[ ]	[ ]	[ ]
Market requirements (e.g. product specification)	[ ]	[ ]	[ ]	[ ]	[ ]
Food product safety and quality	[ ]	[ ]	[ ]	[ ]	[ ]
Community and local interests	[ ]	[ ]	[ ]	[ ]	[ ]
Use of new technologies (e.g. varieties, mechanisation)	[ ]	[ ]	[ ]	[ ]	[ ]

3. At the present time, what is the importance of the influence of the following people or organisations on the way you manage your potato enterprise? Please place a tick in the box for the alternative that best reflects your feeling.

Influences	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Merchants/packers that you supply with potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Retailers that you supply with potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Consumers that buy potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Your farm advisor/consultant	[ ]	[ ]	[ ]	[ ]	[ ]
Your family	[ ]	[ ]	[ ]	[ ]	[ ]
Other farmers	[ ]	[ ]	[ ]	[ ]	[ ]
Local community	[ ]	[ ]	[ ]	[ ]	[ ]
Government and Regulatory Authorities (e.g. Local Government, Environment Agency, MAFF)	[ ]	[ ]	[ ]	[ ]	[ ]
Academic/Research Institutions	[ ]	[ ]	[ ]	[ ]	[ ]
Conservation Organisations (e.g. FRCA, FWAG, RSPB)	[ ]	[ ]	[ ]	[ ]	[ ]
British Potato Council	[ ]	[ ]	[ ]	[ ]	[ ]
Farmer organisations (e.g. NFU, CLA)	[ ]	[ ]	[ ]	[ ]	[ ]
Potato grower association	[ ]	[ ]	[ ]	[ ]	[ ]

4. 10 years ago, i.e. in 1990, what was the importance of the influence of the following people or organisations on the way you managed your potato enterprise? Please place a tick in the box for the alternative that best reflects your feeling.

Influences	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Merchants/packers that you supply with potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Retailers that you supply with potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Consumers that buy potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Your farm advisor/consultant	[ ]	[ ]	[ ]	[ ]	[ ]
Your family	[ ]	[ ]	[ ]	[ ]	[ ]
Other farmers	[ ]	[ ]	[ ]	[ ]	[ ]
Local community	[ ]	[ ]	[ ]	[ ]	[ ]
Government and Regulatory Authorities (e.g. Local Government, Environment Agency, MAFF)	[ ]	[ ]	[ ]	[ ]	[ ]
Academic/Research Institutions	[ ]	[ ]	[ ]	[ ]	[ ]
Conservation Organisations (e.g. FRCA, FWAG, RSPB)	[ ]	[ ]	[ ]	[ ]	[ ]
British Potato Council	[ ]	[ ]	[ ]	[ ]	[ ]
Farmer organisations (e.g. NFU, CLA)	[ ]	[ ]	[ ]	[ ]	[ ]
Potato grower association	[ ]	[ ]	[ ]	[ ]	[ ]

5. At the present time, to what extent do the following factors limit or constrain the performance of your potato enterprise? Please place a tick in the box for the alternative that best reflects your feeling.

Limiting Factors	Extent to which factor limits performance				
	Not at all	Little	Moderately	A lot	Extremely
Quality of labour force	[ ]	[ ]	[ ]	[ ]	[ ]
Land and soil quality	[ ]	[ ]	[ ]	[ ]	[ ]
Water for irrigation	[ ]	[ ]	[ ]	[ ]	[ ]
Climate	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with packers/merchants	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with retailers	[ ]	[ ]	[ ]	[ ]	[ ]
Information about market needs	[ ]	[ ]	[ ]	[ ]	[ ]
Financial resources	[ ]	[ ]	[ ]	[ ]	[ ]
Variability of quality of potatoes produced	[ ]	[ ]	[ ]	[ ]	[ ]
Variability of quantity of potatoes produced	[ ]	[ ]	[ ]	[ ]	[ ]
Variability of potato price	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of advice and technical expertise	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of technology (e.g. varieties, mechanisation)	[ ]	[ ]	[ ]	[ ]	[ ]

6. 10 years ago, i.e. in 1990, to what extent did the following factors limit or constrain the performance of your potato enterprise? Please place a tick in the box for the alternative that best reflects your feeling.

Limiting Factors	Extent to which factor limits performance				
	Not at all	Little	Moderately	A lot	Extremely
Quality of labour force	[ ]	[ ]	[ ]	[ ]	[ ]
Land and soil quality	[ ]	[ ]	[ ]	[ ]	[ ]
Water for irrigation	[ ]	[ ]	[ ]	[ ]	[ ]
Climate	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with packers/merchants	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with retailers	[ ]	[ ]	[ ]	[ ]	[ ]
Information about market needs	[ ]	[ ]	[ ]	[ ]	[ ]
Financial resources	[ ]	[ ]	[ ]	[ ]	[ ]
Variability of quality of potatoes produced	[ ]	[ ]	[ ]	[ ]	[ ]
Variability of quantity of potatoes produced	[ ]	[ ]	[ ]	[ ]	[ ]
Variability of potato price	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of advice and technical expertise	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of technology (e.g. varieties, mechanisation)	[ ]	[ ]	[ ]	[ ]	[ ]

7. Please indicate <u>how much you agree or disagree</u> with the following statements about <u>your</u> potato business.

	AGREE				DISAGREE		
	Totally	**Mostly**	**Slightly**	**Neutral**	**Slightly**	**Mostly**	**Totally**
IN THE LAST 10 YEARS:							
Output per worker has increased	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• My relationships with merchants/packers have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• My relationships with retailers have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• My relationships with my employees have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• My relationships with the local community have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The potatoes I produce are of higher quality	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• My knowledge about market needs has improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Being a potato producer is now more satisfying	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• My use of Information Technology has increased	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• On average the profitability of potato production has improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• My land and soil management practices have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• My management of irrigation has improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The risk of environmental pollution on my farm has reduced	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The skills of my employees have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Reducing the risk of environmental pollution from potato production brings financial benefits	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The financial benefits from improving my employees' skills exceed the associated costs	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Improving the skills of my employees benefits the environment	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Producing organic potatoes could <u>both</u> reduce the risk of environmental pollution and bring financial benefits	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
On balance, the deregulation of the potato industry has been a good thing	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

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8. What is the size of your farm? _____acres or _____ hectares

9. What has been the average annual area of potatoes on your farm over the last 5 years?

_____ acres or _____ hectares

10a. What proportion of your potatoes do you usually supply to?

	% of total volume
Open market	
Merchants/packers	
Retailers	
Directly to consumers (farm shop)	
Elsewhere (please indicate)	
Total	100

10b. What proportion of your potatoes do you usually supply for?

	% of total volume
Fresh (e.g. pre-pack, bag trade)	
Processing (e.g. chipping, crisping)	
Seed	
Total	100

11. Do you participate in an agri-environment or conservation scheme?
Yes ____ No ____ Do not know____
If yes please indicate which _____

12. Have you carried out environmental audit (e.g. LEAF audit) on your farm?
Yes ____ No ____ Do not know____

13. Do you apply a Farm Assurance scheme?
Yes ____ No ____ Do not know____

14. Have you adopted elements of 'Precision Farming' technology in your potato enterprise?
Yes ____ No ____ Do not know____

15. Do you have a staff development/training programme in place?

Yes ____ No ____ Do not know____

16. Do you participate in a potato growers' association or equivalent group?
Yes ____ No ____ Do not know____

17. Have you increased the level of investment in your potato enterprise in the last 10 years in any of the following:?

	Yes	No	Do not know
Irrigation			
Harvesting systems			
Grading			
Storage			

Please indicate whether you would like a personal summary of the survey results when they are ready: Yes____ No____

Please return the completed questionnaire in the enclosed pre-paid envelope. Thank you for your co-operation.

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2nd Phase of Farmers' Questionnaire

Dear Sir,

RE: Performance of the Supply Chain for Potatoes

Cranfield University at Silsoe and the British Potato Council would like to thank you for participating in the survey of the factors, which influence the management of the supply chain for potatoes. The data derived from the questionnaires are being analysed and you will soon be informed about the results.

The PRIZE DRAW for those growers that completed and returned the questionnaires was held at Cranfield University at Silsoe in March 7th 2001and the winner is ..... Mr ..... has been contacted and a visit from ..... expert on ..... management has been arranged for the 2001

Further to the data collected so far, the research team found that additional information about the trade off among financial, environmental and social factors in growers management of their potato enterprise would prove crucial in identifying the relevant importance of the above mentioned factors. A two pages questionnaire has been designed to capture this information and a sample of those growers that responded to the first part of the survey has been selected.

Taking into consideration how valuable is your time, especially this period, we tried to keep the questionnaire as simple as possible and relevant examples are given to facilitate you to fill it in.

Similar types of questions are being sent to a sample of packers and retailers in the potato supply chain, so it is important that growers' views are fully represented. All responses will be treated in absolute confidence..

Please return the completed questionnaire in the pre-paid envelope by 20th of March of 2001.

The findings of the survey will be provided to the British Potato Council. If you wish to receive a summary of the findings, please indicate this on the questionnaire and these results will be sent to you when available.

If you have any queries about this survey, please do not hesitate to contact me at the above address, by telephone or e-mail.

Many thanks for helping in this important research which will be of considerable benefit to the industry,

Yours sincerely

Joe Morris
Professor, Resource Economics and Management

Please indicate how much you agree or disagree with the following statements regarding the future of your potato enterprise.

	AGREE				DISAGREE		
	Totally	Mostly	Slightly	Neutral	Slightly	Mostly	Totally
In the next 10 years, in order to guarantee the success of your potato enterprise you will need to:							
• Achieve closer relationships with other participants in the supply chain	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Increase quality assurance (including traceability of product)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Increase yields	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Improve targeting of potatoes to different market and customer requirements	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Increase cost efficiency in potato production	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Increase economies of scale or specialisation	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Improve waste management	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Increase the adoption of advanced technology (e.g. precision farming, precision irrigation, information technology)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Improve land and soil management	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Improve energy efficiency	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Improve access to irrigation water and/or irrigation efficiency	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Reduce environmental impact	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Demonstrate stronger compliance with good social and environmental practices	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Improve the quality of human resources	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
In the next 10 years, the following will occur:							
• The majority of British fresh potatoes will be produced under Farm Assurance Schemes	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Competition in Britain from globally sourced potatoes will be intense	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Potatoes imported into Britain will conform with the equivalent of Farm Assurance Schemes	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• British potato producers will focus on producing local produce for local markets	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Organic fresh potatoes will account of more than 10% share of the total British market	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The adoption of genetically modified potato varieties will be widespread	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

ALTERNATIVE FEATURES OF PRODUCTION SYSTEMS FOR FRESH POTATOES

Imagine that you have a choice of production systems for fresh potatoes, which vary in terms of their economic, environmental and social characteristics. For example, some systems may be particularly profitable but at the same time potentially damaging to the environment and/or have undesirable social impacts. The table below describes different levels (low-medium-high) economic, environmental and social performance for fresh potato supply systems.

Economic Performance	Environmental Performance	Social Performance
Low: low financial performance, with risk of losses in some years, barely worthwhile.	**Low:** little importance attached to environment, with risk of environmental damage and in some cases non-compliance with legal requirements.	**Low:** little concern with business reputation in local community and risk of non-compliance with legal requirements on employment, trading practices and food safety.
Medium: acceptable and reasonable financial return in most years, relatively attractive enterprise.	**Medium:** generally adopt good environmental practice and comply with legal obligations.	**Medium:** generally concerned to have a good business reputation in the local community, demonstrating compliance with legal requirements on employment, trading practices and food safety
High: maximum financial return: consistently high profitability.	**High:** very strong commitment to a high level of environmental protection and improvement, well beyond legal requirements.	**High:** very strong commitment to a high business reputation in the local community, actively promoting employment, trading standards and food safety standards in excess of legal requirements

The table below describes possible potato production systems in terms of a combination of characteristics. Please, could you indicate the degree of preference for each one considered <u>separately</u> by allocating a score accordingly <u>on a scale of 1 to 9, where 1=LEAST PREFERRED and 9=MOST PREFERRED.</u> For example, it is quite probable that the scenario where the economic, environmental and social performance are all HIGH could be scored 9 (most preferred), while the scenario where all performances are LOW could be scored 1 (least preferred).

CASE	ECONOMIC PERFORMANCE	ENVIRONMENTAL PERFORMANCE	SOCIAL PERFORMANCE		SCORE									
Example	HIGH	HIGH	HIGH	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
Example	LOW	LOW	LOW	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
1	High	Low	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
2	Medium	High	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
3	Low	High	Medium	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
4	Medium	Medium	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
5	Low	Low	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
6	High	Medium	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
7	High	Medium	Medium	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
8	Medium	Low	Medium	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
9	Low	High	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
10	High	High	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
11	Low	Medium	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred

Please indicate whether you would like a personal summary of the survey results when they are ready: Yes____ No____

Please return the completed questionnaire in the enclosed pre-paid envelope. Thank you for your co-operation.

Cranfield UNIVERSITY Silsoe

APPENDIX 3

MERCHANTS' QUESTIONNAIRE

1st Phase of Merchants' Questionnaire

Dear Sir,

With the help of the **British Potato Council**, Cranfield University at Silsoe is researching the factors which influence the management of the supply chain for potatoes and how these may have changed over the last ten years.

The attached questionnaire is designed to capture the views of packers like yourself for this important research. The findings of the enquiry will help us to understand the pressures on the industry and how the industry has responded to these. Linked with other research, it will help to identify actions which can help to secure a sustainable and rewarding future for those who work within it.

Similar types of questions are being sent to a sample of growers and retailers in the potato supply chain, so it is important that packers' views are fully represented. All responses will be treated in absolute confidence.

Please return the completed questionnaire in the pre-paid envelope by April 25th 2001.

If you have any queries about this survey, please do not hesitate to contact me at the above address, by telephone or e-mail. If you wish to receive a summary of the findings, please indicate this on the questionnaire and these results will be sent to you when available

Many thanks for helping in this important research which will be of considerable benefit to the industry,

Yours sincerely

Joe Morris
Professor, Resource Economics and Management

1. At the present time, how important are the following factors in your management decisions for your potato business? Please place a tick in the box for the alternative that best reflects your feeling.

Factors	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Profitability	[ ]	[ ]	[ ]	[ ]	[ ]
Management of natural resources (e.g. energy and water use)	[ ]	[ ]	[ ]	[ ]	[ ]
Environmental risk (e.g. water pollution)	[ ]	[ ]	[ ]	[ ]	[ ]
Personnel management	[ ]	[ ]	[ ]	[ ]	[ ]
Business uncertainty (e.g. variation in supply, demand and prices)	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with the rest of supply chain (e.g. with retailers and farmers)	[ ]	[ ]	[ ]	[ ]	[ ]
Market requirements (e.g. product specification)	[ ]	[ ]	[ ]	[ ]	[ ]
Food product safety and quality	[ ]	[ ]	[ ]	[ ]	[ ]
Community and local interests	[ ]	[ ]	[ ]	[ ]	[ ]
Use of new technologies (e.g. refrigeration, transportation)	[ ]	[ ]	[ ]	[ ]	[ ]

2. 10 years ago, i.e. in 1990, how important were the following factors in your management decisions for your potato business? Please place a tick in the box for the alternative that best reflects your feeling.

Factors	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Profitability	[ ]	[ ]	[ ]	[ ]	[ ]
Management of natural resources (e.g. energy and water use)	[ ]	[ ]	[ ]	[ ]	[ ]
Environmental risk (e.g. water pollution)	[ ]	[ ]	[ ]	[ ]	[ ]
Personnel management	[ ]	[ ]	[ ]	[ ]	[ ]
Business uncertainty (e.g. variation in supply, demand and prices)	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with the rest of supply chain (e.g. with retailers and farmers)	[ ]	[ ]	[ ]	[ ]	[ ]
Market requirements (e.g. product specification)	[ ]	[ ]	[ ]	[ ]	[ ]
Food product safety and quality	[ ]	[ ]	[ ]	[ ]	[ ]
Community and local interests	[ ]	[ ]	[ ]	[ ]	[ ]
Use of new technologies (e.g. refrigeration, transportation)	[ ]	[ ]	[ ]	[ ]	[ ]

3. At the present time, what is the importance of the influence of the following people or organisations on the way your potato business is managed? Please place a tick in the box for the alternative that best reflects your feeling.

Influences	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Retailers that you supply with fresh potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Growers that supply fresh potatoes to you	[ ]	[ ]	[ ]	[ ]	[ ]
Consumers that buy potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Advisors/Consultants to your business	[ ]	[ ]	[ ]	[ ]	[ ]
Other suppliers/packers	[ ]	[ ]	[ ]	[ ]	[ ]
Local community	[ ]	[ ]	[ ]	[ ]	[ ]
Government and Regulatory Authorities (e.g. Local Government, Environment Agency)	[ ]	[ ]	[ ]	[ ]	[ ]
Academic/Research Institutions	[ ]	[ ]	[ ]	[ ]	[ ]
Non-Governmental Environmental Organisations (e.g. Wildlife Trust, Friends of the Earth)	[ ]	[ ]	[ ]	[ ]	[ ]
Consumer Organisations (e.g. Consumer Association)	[ ]	[ ]	[ ]	[ ]	[ ]
British Potato Council	[ ]	[ ]	[ ]	[ ]	[ ]
Suppliers/Packers Organisation	[ ]	[ ]	[ ]	[ ]	[ ]

4. 10 years ago, i.e. in 1990, what was the importance of the influence of the following people or organisations on the way your potato business was managed? Please place a tick in the box for the alternative that best reflects your feeling.

Influences	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Retailers that you supply with fresh potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Growers that supply fresh potatoes to you	[ ]	[ ]	[ ]	[ ]	[ ]
Consumers that buy potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Advisors/Consultants to your business	[ ]	[ ]	[ ]	[ ]	[ ]
Other suppliers/packers	[ ]	[ ]	[ ]	[ ]	[ ]
Local community	[ ]	[ ]	[ ]	[ ]	[ ]
Government and Regulatory Authorities (e.g. Local Government, Environment Agency)	[ ]	[ ]	[ ]	[ ]	[ ]
Academic/Research Institutions	[ ]	[ ]	[ ]	[ ]	[ ]
Non-Governmental Environmental Organisations (e.g. Wildlife Trust, Friends of the Earth)	[ ]	[ ]	[ ]	[ ]	[ ]
Consumer Organisations (e.g. Consumer Association)	[ ]	[ ]	[ ]	[ ]	[ ]
British Potato Council	[ ]	[ ]	[ ]	[ ]	[ ]
Suppliers/Packers Organisation	[ ]	[ ]	[ ]	[ ]	[ ]

5. <u>At the present time</u>, to what extent do the following factors <u>limit or constrain the performance</u> of your potato business? Please place a tick in the box for the alternative that best reflects your feeling.

Limiting Factors	Extent to which factor limits performance				
	Not at all	Little	Moderately	A lot	Extremely
Quality of labour force	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with retailers	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with farmers	[ ]	[ ]	[ ]	[ ]	[ ]
Information about market needs	[ ]	[ ]	[ ]	[ ]	[ ]
Financial resources	[ ]	[ ]	[ ]	[ ]	[ ]
Variability of fresh potatoes quality	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of quantity needed	[ ]	[ ]	[ ]	[ ]	[ ]
Variability in fresh potato price	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of technology (e.g. storage, packaging)	[ ]	[ ]	[ ]	[ ]	[ ]

6. <u>10 years ago</u>, i.e. in 1990, to what extent did the following factors <u>limit or constrain the performance</u> of your potato business? Please place a tick in the box for the alternative that best reflects your feeling.

Limiting Factors	Extent to which factor limits performance				
	Not at all	Little	Moderately	A lot	Extremely
Quality of labour force	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with retailers	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with farmers	[ ]	[ ]	[ ]	[ ]	[ ]
Information about market needs	[ ]	[ ]	[ ]	[ ]	[ ]
Financial resources	[ ]	[ ]	[ ]	[ ]	[ ]
Variability of fresh potatoes quality	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of quantity needed	[ ]	[ ]	[ ]	[ ]	[ ]
Variability in fresh potato price	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of technology (e.g. storage, packaging)	[ ]	[ ]	[ ]	[ ]	[ ]

7. Please indicate how much you agree or disagree with the following statements about your potato business.

	AGREE				DISAGREE		
	Totally	Mostly	Slightly	Neutral	Slightly	Mostly	Totally
IN THE LAST 10 YEARS:							
• Output per worker has increased	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Relationships with retailers have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Relationships with growers have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Relationships with its employees have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Relationships with local community have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The services (e.g. quality, variety, continuous supply) that my business offers to its customers have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Fresh potatoes sold by my business are of significantly higher quality	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Knowledge about market needs has improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• My business's use of Information Technology has increased significantly	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• On average the profitability on fresh potatoes has improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The management of natural resources has improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The risk of environmental pollution from my business has reduced	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The skills and competencies of employees have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Reducing the risk of environmental pollution from my business activities brings financial benefits	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The financial benefits from improving my business's employee skills exceed the associated costs	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Improving the skills of my business's employees benefits the environment	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Organic potatoes could <u>both</u> reduce the risk of environmental pollution and bring financial benefits to my business	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Organic potatoes could <u>both</u> reduce the risk of environmental pollution and bring financial benefits to <u>all</u> the participants of supply chain for fresh potatoes	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
On balance, the deregulation of the potato industry has been a good thing	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

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8. What is the average annual volume of fresh potatoes sold by your business in the last 3 years?
_____ tonnes

9a. What proportion of your potatoes do you usually source from?

	% of total volume
Abroad	
Dedicated UK farmers	
Occasional UK farmers	
Elsewhere (please indicate)	
Total	100

9b. What proportion of your potatoes do you usually supply to?

	% of total volume
Wholesale market	
Major Retailers	
Small retailers (greengrocers)	
Caterers	
Processors	
Elsewhere (please indicate)	
Total	100

10. Has an environmental audit been carried out on your business?
Yes____ No_____ Do not Know____

11. In the last 10 years, has your company adopted any new technology to:

	YES	NO	Do Not Know
Minimise refrigerant emissions?			
Minimise emissions related to transportation?			
Improve water-recycling policy?			
Save energy?			

12. What proportion of the potatoes bought by your business has been produced under an Integrated Crop Management protocol scheme? % of volume ____ Do not Know____

13. What proportion (volume) of the potatoes bought by your business are organic?
% of volume ____ Do not Know____

14. Does your company have a staff development/training programme in place?
Yes____ No____ Do not Know____

15. Does your company participate in any suppliers/packers association or equivalent group?
Yes____ No____ Do not Know____

16. Has your business increased the level of investment in the last 10 years in any of the following:?

	YES	NO	Do Not Know
Recycling wastes			
Refrigeration			
Storage			
Grading			
Washing			
Transportation			
Packaging			
Energy Management			
Water Management			

Please indicate whether you would like a personal summary of the survey results when they are ready:
Yes____ No____

If yes, Address: _____

Please return the completed questionnaire in the enclosed pre-paid envelope. Thank you for your co-operation.

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Silsoe

2nd Phase of Merchants' Questionnaire

Dear

RE: Survey of Potato Packers regarding Sustainability of the Supply Chain

You very kindly completed a questionnaire for us in March, which we carried out with the help of the British Potato Council. We have had an excellent response from the 30 or so packers to whom we sent our questionnaire, and we are currently progressing the results.

Given your willingness to help answer our questions last time, we respectfully ask if you would be willing to answer **one final** question. It seeks your views on the relative importance of economic, social and environmental factors as they influence your business. You will appreciate that, given the challenges facing the farming and food industry at the moment, this is quite a topical subject.

Once again, your responses are treated **confidentially**.

We very much hope you will find a few moments to help us with this **one final question**.

Please return the completed questionnaire in the pre-paid envelope by April 25th 2001.

If you have any questions regarding the question or the research, please contact me at the above address.

Kindest regards,

Joe Morris
Professor, Resource Economics and Management

ALTERNATIVE FEATURES OF SUPPLY SYSTEMS FOR FRESH POTATOES

Imagine that you have a choice of supply systems (Grower-Supplier) for fresh potatoes, which vary in terms of their economic, environmental and social characteristics. For example, some systems may be particularly profitable, for the participants of the supply system, but at the same time potentially damaging to the environment and/or have undesirable social impacts. The table below describes different levels (low-medium-high) economic, environmental and social performance for fresh potato supply systems.

Economic Performance	Environmental Performance	Social Performance
Low: low financial performance, with risk of losses in some years, barely worthwhile.	**Low:** little importance attached to environment, with risk of environmental damage and in some cases non-compliance with legal requirements.	**Low:** little concern with business reputation in local community and risk of non-compliance with legal requirements on employment, trading practices and food safety.
Medium: acceptable and reasonable financial return in most years, relatively attractive enterprise.	**Medium:** generally adopt good environmental practice and comply with legal obligations.	**Medium:** generally concerned to have a good business reputation in the local community, demonstrating compliance with legal requirements on employment, trading practices and food safety
High: maximum financial return: consistently high profitability.	**High:** very strong commitment to a high level of environmental protection and improvement, well beyond legal requirements.	**High:** very strong commitment to a high business reputation in the local community, actively promoting employment, trading standards and food safety standards in excess of legal requirements

The table below describes possible fresh potato supply systems in terms of a combination of characteristics. Please, could you indicate the degree of preference for each one considered **separately** by allocating a score accordingly **on a scale of 1 to 9, where 1=LEAST PREFERRED and 9=MOST PREFERRED.** For example, it is quite probable that the scenario where the economic, environmental and social performance are all HIGH could be scored 9 (most preferred), while the scenario where all performances are LOW could be scored 1 (least preferred).

CASE	ECONOMIC PERFORMANCE	ENVIRONMENTAL PERFORMANCE	SOCIAL PERFORMANCE		SCORE									
Example	HIGH	HIGH	HIGH	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
Example	LOW	LOW	LOW	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
1	High	Low	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
2	Medium	High	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
3	Low	High	Medium	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
4	Medium	Medium	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
5	Low	Low	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
6	High	Medium	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
7	High	Medium	Medium	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
8	Medium	Low	Medium	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
9	Low	High	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
10	High	High	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
11	Low	Medium	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred

Please indicate whether you would like a personal summary of the survey results when they are ready: Yes____ No____

Please return the completed questionnaire in the enclosed pre-paid envelope. Thank you for your co-operation.

Cranfield UNIVERSITY Silsoe

APPENDIX 4

RETAILERS' QUESTIONNAIRE

Dear Sir,

RE: Performance of the Supply Chain for Potatoes

The demands on food retailers to deliver high quality produce to the market at very competitive prices have increased considerably over the last decade. Simultaneously retailers are required to meet higher standards of environmental protection, as well as higher standards of health and safety for employees and food consumers. At the same time, there have been considerable changes in the organisation of the potato industry and management of the supply chain.

With the help of the **British Potato Council**, Cranfield University at Silsoe is researching the factors which influence the management of the supply chain for fresh potatoes and how these may have changed over the last ten years.

The attached questionnaire is designed to capture the views of retailers like yourself for this important research. The findings of the enquiry will help us to understand the pressures on the industry and how the industry has responded to these. Linked with other research, it will help to identify actions which can help to secure a sustainable and rewarding future for those who work within it.

Similar types of questions are being sent to a sample of growers and packers in the potato supply chain, so it is important that retailers' views are fully represented. All responses will be treated in absolute confidence.

Please return the completed questionnaire in the pre-paid envelope by March 14th 2001.

If you have any queries about this survey, please do not hesitate to contact me at the above address, by telephone or e-mail. If you wish to receive a summary of the findings, please indicate this on the questionnaire and these results will be sent to you when available.

Many thanks for helping in this important research which will be of considerable benefit to the industry,

Yours sincerely

Joe Morris
Professor, Resource Economics and Management

Cranfield UNIVERSITY Silsoe

1. At the present time, how important are the following factors on the way your business is managed with respect to fresh potatoes? Please place a tick in the box for the alternative that best reflects your feeling.

Factors	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Profitability	[ ]	[ ]	[ ]	[ ]	[ ]
Management of natural resources (e.g. energy and water use)	[ ]	[ ]	[ ]	[ ]	[ ]
Environmental risk (e.g. associated with refrigeration and transportation)	[ ]	[ ]	[ ]	[ ]	[ ]
Personnel management	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with the rest of supply chain (e.g. with suppliers and growers)	[ ]	[ ]	[ ]	[ ]	[ ]
Business uncertainty (e.g. variation in supply, demand and prices)	[ ]	[ ]	[ ]	[ ]	[ ]
Market requirements (e.g. product specification)	[ ]	[ ]	[ ]	[ ]	[ ]
Food product safety and quality	[ ]	[ ]	[ ]	[ ]	[ ]
Community and local interests	[ ]	[ ]	[ ]	[ ]	[ ]
Use of new technologies (e.g. refrigeration, transportation)	[ ]	[ ]	[ ]	[ ]	[ ]

2. 10 years ago, i.e. in 1990, how important were the following factors on the way your business was managed with respect to fresh potatoes? Please place a tick in the box for the alternative that best reflects your feeling.

Factors	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Profitability	[ ]	[ ]	[ ]	[ ]	[ ]
Management of natural resources (e.g. energy and water use)	[ ]	[ ]	[ ]	[ ]	[ ]
Environmental risk (e.g. associated with refrigeration and transportation)	[ ]	[ ]	[ ]	[ ]	[ ]
Personnel management	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with the rest of supply chain (e.g. with suppliers and growers)	[ ]	[ ]	[ ]	[ ]	[ ]
Business uncertainty (e.g. variation in supply, demand and prices)	[ ]	[ ]	[ ]	[ ]	[ ]
Market requirements (e.g. product specification)	[ ]	[ ]	[ ]	[ ]	[ ]
Food product safety and quality	[ ]	[ ]	[ ]	[ ]	[ ]
Community and local interests	[ ]	[ ]	[ ]	[ ]	[ ]
Use of new technologies (e.g. refrigeration, transportation)	[ ]	[ ]	[ ]	[ ]	[ ]

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3. At the present time, what is the importance of the influence of the following people or organisations on the way your business is managed with respect to fresh potatoes? Please place a tick in the box for the alternative that best reflects your feeling.

Influences	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Suppliers/Packers that supply fresh potatoes to you	[ ]	[ ]	[ ]	[ ]	[ ]
Growers that supply fresh potatoes to you	[ ]	[ ]	[ ]	[ ]	[ ]
Consumers that buy fresh potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Advisors/consultants to your business	[ ]	[ ]	[ ]	[ ]	[ ]
Other retailers	[ ]	[ ]	[ ]	[ ]	[ ]
Local community	[ ]	[ ]	[ ]	[ ]	[ ]
Government and Regulatory Authorities (e.g. Local Government, Environment Agency)	[ ]	[ ]	[ ]	[ ]	[ ]
Academic/Research Institutions	[ ]	[ ]	[ ]	[ ]	[ ]
Non-Governmental Organisations (e.g. Wildlife Trust, Friends of the Earth)	[ ]	[ ]	[ ]	[ ]	[ ]
Consumer Organisations (e.g. Consumer Association)	[ ]	[ ]	[ ]	[ ]	[ ]
British Potato Council	[ ]	[ ]	[ ]	[ ]	[ ]
Retailer Organisation	[ ]	[ ]	[ ]	[ ]	[ ]

4. 10 years ago, in 1990, what was the importance of the influence of the following people or organisations on the way your business was managed with respect to fresh potatoes? Please place a tick in the box for the alternative that best reflects your feeling.

Influences	Degree of Importance				
	Not at all	Little	Moderately	A lot	Extremely
Suppliers/Packers that supply fresh potatoes to you	[ ]	[ ]	[ ]	[ ]	[ ]
Growers that supply fresh potatoes to you	[ ]	[ ]	[ ]	[ ]	[ ]
Consumers that buy fresh potatoes	[ ]	[ ]	[ ]	[ ]	[ ]
Advisors/consultants to your business	[ ]	[ ]	[ ]	[ ]	[ ]
Other retailers	[ ]	[ ]	[ ]	[ ]	[ ]
Local community	[ ]	[ ]	[ ]	[ ]	[ ]
Government and Regulatory Authorities (e.g. Local Government, Environment Agency)	[ ]	[ ]	[ ]	[ ]	[ ]
Academic/Research Institutions	[ ]	[ ]	[ ]	[ ]	[ ]
Non-Governmental Organisations (e.g. Wildlife Trust, Friends of the Earth)	[ ]	[ ]	[ ]	[ ]	[ ]
Consumer Organisations (e.g. Consumer Association)	[ ]	[ ]	[ ]	[ ]	[ ]
British Potato Council	[ ]	[ ]	[ ]	[ ]	[ ]
Retailer Organisation	[ ]	[ ]	[ ]	[ ]	[ ]

5. At the present time, to what extent do the following factors limit or constrain the performance of your business with respect to fresh potatoes? Please place a tick in the box for the alternative that best reflects your feeling.

Limiting Factors	Extent to which factor limits performance				
	Not at all	Little	Moderately	A lot	Extremely
Quality of labour force	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with packers/suppliers	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with farmers	[ ]	[ ]	[ ]	[ ]	[ ]
Information about market needs	[ ]	[ ]	[ ]	[ ]	[ ]
Financial resources	[ ]	[ ]	[ ]	[ ]	[ ]
Variability of fresh potatoes quality	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of quantity needed	[ ]	[ ]	[ ]	[ ]	[ ]
Variability in fresh potato price	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of technology (e.g. refrigeration, transportation)	[ ]	[ ]	[ ]	[ ]	[ ]

6. 10 years ago, i.e. in 1990, to what extent did the following factors limit or constrain the performance of your business with respect to fresh potatoes? Please place a tick in the box for the alternative that best reflects your feeling.

Limiting Factors	Extent to which factor limits performance				
	Not at all	Little	Moderately	A lot	Extremely
Quality of labour force	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with packers/suppliers	[ ]	[ ]	[ ]	[ ]	[ ]
Relationships with farmers	[ ]	[ ]	[ ]	[ ]	[ ]
Information about market needs	[ ]	[ ]	[ ]	[ ]	[ ]
Financial resources	[ ]	[ ]	[ ]	[ ]	[ ]
Variability of fresh potatoes quality	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of quantity needed	[ ]	[ ]	[ ]	[ ]	[ ]
Variability in fresh potato price	[ ]	[ ]	[ ]	[ ]	[ ]
Availability of technology (e.g. refrigeration, transportation)	[ ]	[ ]	[ ]	[ ]	[ ]

7. Please indicate how much you agree or disagree with the following statements about your business with respect to fresh potatoes.

	AGREE				DISAGREE		
	Totally	**Mostly**	**Slightly**	**Neutral**	**Slightly**	**Mostly**	**Totally**
IN THE LAST 10 YEARS:							
• Output per worker has increased	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Relationships with suppliers have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Relationships with growers have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Relationships with employees have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Relationships with local community have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The services (e.g. quality, variety, continuous supply) that my business offers to its customers have improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Fresh potatoes sold by my business are of significantly higher quality	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• Knowledge about market needs has improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• My business's use of Information Technology has increased significantly	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• On average the profitability on fresh potatoes has improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The management of natural resources has improved	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The risk of environmental pollution from my business has reduced	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
• The skills and competencies of employees have improved in the last 10 years	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Reducing the risk of environmental pollution from my business's activities brings financial benefits	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
The financial benefits from improving my business's employee skills exceed the associated costs	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Improving the skills of business's employees benefits the environment	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Organic potatoes could <u>both</u> reduce the risk of environmental pollution and bring financial benefits to my business	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Organic potatoes could <u>both</u> reduce the risk of environmental pollution and bring financial benefits to <u>all</u> participants of supply chain for fresh potatoes	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
On balance, the deregulation of the potato industry has been a good thing	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

8. **What is the average annual volume of fresh potatoes sold by your business in the last 3 years?**
_____ **tonnes**

9. **What proportion of your fresh potatoes do you usually source from?**

	% of total volume
Abroad	
UK Wholesale market	
UK Dedicated suppliers/packers	
UK Growers	
Elsewhere (please indicate)	
Total	100

10. **Has an environmental audit been carried out on your business?**
Yes____ No____ Do not know____

11. **In the last 10 years has your company adopted new technology to:**

	Yes	No	Do not know
Minimise refrigerant emissions?			
Minimise emissions related to transportation?			
Save energy?			

12. **What proportion of the fresh potatoes bought by your business has been produced under an Integrated Crop Management protocol scheme?**
% of volume _ Do not Know___

13. **What proportion of the fresh potatoes bought by your business are organic?**
% of volume _ Do not Know___

14. **Does your company have a staff development/training programme in place specifically for fresh produce?**
Yes____ No____ Do not know____

15. **Does your company participate in a retailers association or equivalent group specifically for fresh produce?**
Yes____ No____ Do not know____

16. **Has your business <u>increased</u> the level of investment in the last 10 years in any of the following specifically for fresh produce:?**

	Yes	No	Do not know
Recycling wastes			
Refrigeration			
Transportation			
Energy Management			

ALTERNATIVE FEATURES OF SUPPLY CHAIN SYSTEMS FOR FRESH POTATOES

Imagine that you have a choice of supply chain systems (Grower-Supplier-Retailer) for fresh potatoes, which vary in terms of their economic, environmental and social characteristics. For example, some systems may be particularly profitable, for the participants of the supply chain system, but at the same time potentially damaging to the environment and/or have undesirable social impacts. The table below describes different levels (low-medium-high) economic, environmental and social performance for fresh potato supply systems.

Economic Performance	Environmental Performance	Social Performance
Low: low financial performance, with risk of losses in some years, barely worthwhile.	**Low:** little importance attached to environment, with risk of environmental damage and in some cases non-compliance with legal requirements.	**Low:** little concern with business reputation in local community and risk of non-compliance with legal requirements on employment, trading practices and food safety.
Medium: acceptable and reasonable financial return in most years, relatively attractive enterprise.	**Medium:** generally adopt good environmental practice and comply with legal obligations.	**Medium:** generally concerned to have a good business reputation in the local community, demonstrating compliance with legal requirements on employment, trading practices and food safety
High: maximum financial return: consistently high profitability.	**High:** very strong commitment to a high level of environmental protection and improvement, well beyond legal requirements.	**High:** very strong commitment to a high business reputation in the local community, actively promoting employment, trading standards and food safety standards in excess of legal requirements

The table below describes possible fresh potato supply chain systems in terms of a combination of characteristics. Please, could you indicate the degree of preference for each one considered **separately** by allocating a score accordingly **on a scale of 1 to 9, where 1=LEAST PREFERRED and 9=MOST PREFERRED.** For example, it is quite probable that the scenario where the economic, environmental and social performance are all HIGH could be scored 9 (most preferred), while the scenario where all performances are LOW could be scored 1 (least preferred).

CASE	ECONOMIC PERFORMANCE	ENVIRONMENTAL PERFORMANCE	SOCIAL PERFORMANCE		SCORE									
Example	HIGH	HIGH	HIGH	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
Example	LOW	LOW	LOW	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
1	High	Low	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
2	Medium	High	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
3	Low	High	Medium	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
4	Medium	Medium	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
5	Low	Low	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
6	High	Medium	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
7	High	Medium	Medium	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
8	Medium	Low	Medium	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
9	Low	High	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
10	High	High	Low	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred
11	Low	Medium	High	Least Preferred	1	2	3	4	5	6	7	8	9	Most Preferred

Please indicate whether you would like a personal summary of the survey results when they are ready: Yes____ No____

Please return the completed questionnaire in the enclosed pre-paid envelope. Thank you for your co-operation.

APPENDIX 5

QUANTITATIVE ASSESSMENT OF THE PERFORMANCE OF FRESH POTATO SUPPLY CHAIN

A.5.1. Introduction

This appendix deals with the findings from the quantitative assessment of the performance of fresh potato supply chain according to selected quantitative indicators. The quantitative survey is similar to a life cycle assessment of key indicators along supply chain, excluding post retail sale. Although it was to an extent feasible to collect data about the sustainability of the supply chain in 2000, it proved difficult to do so for a decade ago. Thus, the analysis focused on the present situation to show the application of the analytical framework.

A.5.2. Fresh Potato Supply Chain Performance According to Sustainability Indicators

Table A.5.19 summarizes the findings from the assessment of fresh potato supply chain performance according to the selected economic, environmental and social indicators. Tables A.5.1 to A.5.18 in Appendix 5 show in detail the sources of data used and the assumptions made to assess supply chain performance. Lack of data prevented the assessment of the supply chain performance in 1990 and thus, it was unfeasible to draw any conclusion about the changes in the supply chain performance over the last decade.

The data selected for the assessment of performance at the farmer stage referred to 1 hectare of potato enterprise as measurement unit. Table A.5.19 summarises the findings of the farm performance assessment using 1 tonne of fresh potatoes bought by consumers as a measurement unit. Table A.5.19 shows also the findings of the

performance assessment of the merchant stage, which referred to 1 tonne of fresh potatoes sold to retailers. Taking into consideration that only 0.5% of fresh potatoes bought by retailer go for waste, it can be assumed that all fresh potatoes sold by merchants are bought by consumers. Table A.5.19 summarizes also the overall assessment of the performance of retail stage per tonne of fresh potatoes sold to consumers.

A.5.2.1. Input efficiency indicators

Economic Indicators

Table A.5.19 shows the assessment of performance according to economic indicators of farm and merchant stages only because it was not feasible to reliably assess the performance at retail stage because relevant data were not available. These estimates derive from the Tables A.5.1 and A.5.8 which deal with the product price, and the costs which comprise the variable and fixed costs of farm potato enterprise and merchant potato business.

Environmental Indicators

Energy consumption

The energy consumed at the farm stage derived from the use of fertilisers, pesticides, labour, fuel and seeds (Table A.5.2). Energy consumption at merchant stage consisted of the electricity used for activities such as storage, grading and packaging and fuel used for potatoes transportation (Table A.5.9). The energy consumption assessed at the retail stage refers mainly to the store use and product transportation. However, data relevant to the energy consumed at the distribution centre were not available (Table A.5.14).

Water consumption

The average volume of water used for irrigation at potato crops in the last 20 years at Silsoe is considered in this study. The water used to wash potatoes from soil at

the merchant stage is also calculated, while it is considered that little water is necessary at the retail stage (Tables A.5.3, A.5.9 and A.5.14).

Social Indicators

Labour

The data for the labour requirements at farm stage derive from secondary sources and the data at merchant and retail stages from estimations made by the technical managers of the merchant and retail businesses (Tables A.5.4, A.5.11 and A.5.16).

A.5.2.2. Output efficiency indicators

Economic Indicators

The financial performance of farm and merchant stages was assessed in terms of net and gross margins. It was not feasible to assess the performance at retail stage because relevant data were not available (Tables A.5.1and A.5.8).

Environmental Indicators

Emissions to air/water/soil

Fertiliser application is responsible for considerable emissions to air, water and soil at farm stage (Audsley, 1998, Brentrup, 1998). In this context, nitrate leaching and phosphorous emissions to surface water, and nitrous oxide and ammonia emissions to air are considered in this study. Moreover, CO_2 emissions to air from fertiliser production are calculated (Audsley et al, 1997). CO_2 and SO_2 emissions to air from fuel consumption for farm activities are also reported (Table A.5.6).

Emissions to air at merchant and retail stages come from energy consumption and fuel used for transportation (CO_2 and SO_2) (Tables A.5.12 and A.5.17).

Pesticide leaching

The data and the model of pesticide leaching calculation were provided by National Soil Resources Institute at Silsoe. These data refer to the average pesticide application on potatoes in East Anglia and the soil type of this area, because it is one of the main potato production areas in the UK (Table A.5.5).

Wastes

Wastes at farm and merchant stages comprise the fresh potatoes sold for stockfeed because they are not considered suitable for the market. A small volume of purchased potatoes goes for waste at the retail stage, because they get bad during the display time. Packaging materials were considered to be of little importance at merchant and retail stages, and relevant data were not available (Tables A.5.1, A.5.10 and A.5.15).

Social Indicators

Personnel training

There were no available data related to personnel training at farm level. The marketing and store managers of the merchant and retail organizations, respectively, roughly estimated the time spent per employee for personnel training, because their organizations did not collect relevant data (Tables A.5.11 and A.5.16).

A.5.2.3. Allocation indicators

The assessment of the overall performance of farm, merchant and retail stages according to selected sustainability indicators was not complete. However, it was feasible to determine the contribution of farmer, merchant and retailer stage in selected indicators such as energy and water consumption, CO_2 emissions to air, wastes of fresh potatoes and labour requirement (Figure A.5.1). Thus, most of the energy is consumed at farm and merchant stage (around 45% and 40% respectively), and around 15% is consumed at retail stage. This can be explained because more energy consuming

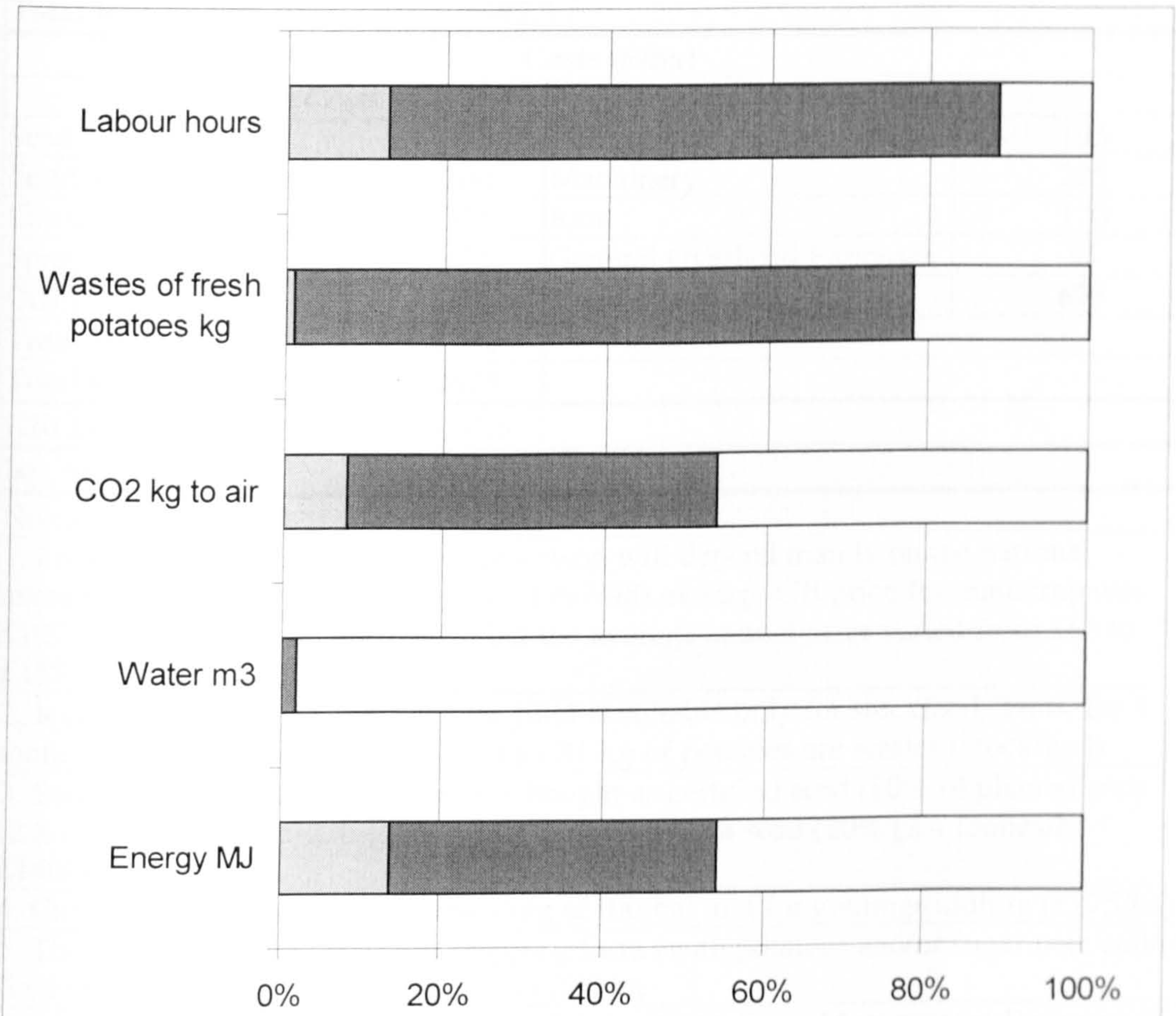
activities are required to produce and merchandise fresh potatoes than retailing. The farm stage is also responsible for almost all water consumption in the supply chain, because of crop irrigation. CO_2 is mainly emitted at farmer and merchant stage and only 8% at retail stage. This can be attributed to the short stay of fresh potatoes at the retail stage and to the few activities involved compared with the merchant and farm stage. The great majority of fresh potato wastes come from the merchant stage and to lesser extent from the farm, while waste at retail stage is minimal. This is because a significant volume of fresh potatoes is stored up to six months by merchant in order to provide continuous supplies to retailers. The merchant stage is also the most labour demanding, while farm and retail stage account for around 12% each on labour requirement.

A.5.3. Recommendations Emerging from the Quantitative Survey

The quantitative survey did not provide a measurement of the changes in the fresh potato supply chain performance during the last decade because of the lack of adequate data, especially in 1990. However, the assessment of the supply chain performance according to the selected sustainability indicators is more complete for 2000. Therefore, it is recommended that this analytical framework is further developed and applied in the fresh potato supply chain on a regular basis in the future by supply chain participants or governmental agencies. This could help to measure and monitor the trends of the sustainability of the supply chain over time.

The study revealed the importance of relationships, trust and shared values, norms of behaviour, adoption of good practices and duty of care amongst the participants in the fresh produce supply chain. This could be perceived as social capital, an important element of the sustainability of the supply chain. Thus, some indicators such as the volume of the fresh produce traded under contract agreements, the company's participation in the industry's organizations and associations, employees' qualifications and the adoption of good practices could also be included as indicators the quantitative survey. 'Food miles' is another sustainability indicator that has received attention in the food supply chain in the recent past and it could be included in the analytical framework.

Figure A.5.1. Farmers, merchants and retailers' performance according to selected sustainable development indicators (units/ tonne of potatoes sold to consumers)



	Energy MJ	Water m^3	CO_2 kg to air	Wastes of fresh potatoes kg	Labour hours
RETAILER	190	0	9.5	5	2.1
MERCHANT	560	0.9	54.5	399	12.5
FARMER	630	49.8	55.1	113	1.9

Table A.5.1. Costs and profits of fresh potato production

Revenues			
Yield: tonnes/ha:	43.5	Revenues @ £/t	Revenues @ £/ha
Ware: (92.5% of total yield)	39.3	75	2947.5
Stockfeed (7.5% of total yield)	3.2	12.5	40
Total Revenue @ £/ha	**2987.5**		

Costs (£/ha)			
Variable Costs		**Fixed Costs**	
Seed	575	Labour	195
Fertiliser	200	Machinery	225
Casual labour:	375	Rent	170
Sprays	425	General Overhead Expenses	85
Other crop expenses	375	**Total Fixed costs**	**675**
Total Variable Costs	**1950**		
Total Costs £/ha	**2625**		
GROSS MARGIN £/ha	**1037.5**		
Net Margin £/ha	**362.5**		

Notes:

1. Prices. The actual price in any one season will depend mainly on the national average yield. The five year (1993/94-1997/98) average GB price for maincrop was £103 (£113 in 2000 money values) but the average annual price varied from £66 to £157 per tonne

2. It is assumed that 7.5% if the total yield is suitable only for stockfeed. Thus, for 1 tonne of fresh potatoes sold to merchant 81 kg of potatoes are wastes (stockfeed)

3. Seed price depends on whether it is bought as certified seed (80% of planted area (2.8 tonnes/ha * £225-230/tonne)) or it is once-grown seed (20% (2.4 tonnes/ha * £140/tonne))

4. Casual labour is referred to harvesting (£100/ha) and for grading/riddling (£275/ha)

5. The fixed costs refer to mixed cropping farm (with potatoes and/or sugar beet and/or field vegetables: grade 1 or 2 land) over 200 ha

6. All information and data comes from J. Nix (2000) Farm Management Pocketbook 30th edition

Table A.5.2. Energy consumption of fresh potato production

Energy carriers	Units of Energy carrier used	Energy MJ/unit	Energy MJ/ha
Fertilisers kg/ha			
N	180[1]	47.03[2]	8465.4
P2O5	150[1]	15.27[2]	2290.5
K2O5	220[1]	9.28[2]	2041.6
Fertilisers Subtotal			12797.5
Labour hours/ha	52[1]	0.27[3]	14.04
Fuel Oil lt/ha	71[4,6]	43.3[3]	3074.3
Pesticides (gr of active ingredient)	18.684[7]	97.06[3]	1813.469

Table A.5.2. Energy consumption of fresh potato production (continued)			
Seeds (tonnes)	2.8[5]	2.8[5]	**7.84**
Total Energy (MJ/ha)			**17707.15**
Notes:			
1. Data from L. Chadwick (1999)			
2. Data from J. Moerschner et al (1998).			
3. Data from F. Leiva (1997).			
4. Data from E. Audsley (1998).			
5. Data from J. Nix (2000).			
6. Fuel oil consumption consists of (l/ha): 25 for ploughing, 3 for fertiliser distribution, 21 for potato harvesting, 8 for potato planting, 1 for spraying and 13 for cultivation (Audsley, 1998).			
7. From Table A.5.5 of Pesticide Leaching			

Table A.5.3. Water consumption of fresh potato production

	Irrigation	Total
Water consumption cubic meters/ha	**1400 [2]**	**1400**
Notes:		
1. The volume of water used for irrigation of maincrop potatoes varies a lot among years and areas of the country. 140 mm water depth is the average irrigation used in the last 20 years at Silsoe [3], which is located in one of the driest areas of England.		
2. Data from MAFF (1997).		
3. From Knox, J. and K. Weatherhead (2000)..		

Table A.5.4. Labour requirements and personnel training of fresh potato production

	Labour (hours/ha)
Plough	1
Cultivating, Ridging, Destoning	5
Plant and apply fertiliser [1]	3.5
Apply herbicide	0.2
Spray for blight	0.9
Burn off haulm	0.2
Harvest, Cart, Clamp[2]	10
Work on indoor clamp	3.2
Riddle, Bag, Load	30
Total	54
Notes:	
1, Automatic planter. Hand fed planters: approx. 12 hours plus 8 t/ha could be casual labour.	
2,Mechanical harvester, excluding up to 25 hours for picking off on harvester-usually casual labour.	
3, These data are for premium farms	
4,All information and data comes from J. Nix (2000).	
5. Data related to personnel training was not obtained.	

Table A.5.5. Pesticide leaching of fresh potato production

Pesticide	Average Cumulative dose gr of active ingredient (ai)/ha of crop receiving that ai	Total Leaching µg/ha	Vulnerability assessment
Paraquat	383	3.95E-07	LOW
Metribuzin	1066	4.69357	HIGH
Diquat	356	3.61E-05	LOW
Mancozeb	5632	0.96685	MOD
Maneb	1509	12.1352	HIGH
Primicarb	364	0.83323	MOD
Aldicarb	3057	15.2469	HIGH
Oxamyl	5189	7.03039	HIGH
Glufosinate	642	0.35032	MOD
TOTAL	18684	41.2565	

Notes:

1. The data and the model of pesticide leaching calculation have been provided by National Soil Resources Institute at Silsoe.

Table A.5.6. Emissions to air/water/soil of fresh potato production

Nitrate Leaching (kg/ha) or Bww= (OSMN+FertN+FixN-Offtake)*D/(D+AWC) or Bww= ((N-n_1*Y_1-n_2*Y_2+25)*120)/(120+33+67*s) [5]	
N (the required amount of nitrogen for the crop) (kg)	180 [2]
n_1 (nitrogen in crop offtake for primary yield Kg N/t (fresh weight)	3.25 [5]
n_2 (nitrogen in crop offtake for secondary yield Kg N/t (fresh weight)	3.25 [5]
Y_1 the primary yield (t/ha)	39.3 [1]
Y_2 the secondary yield (t/ha)	3.2 [1]
s: the soil type index (1 for sandy loam and 2 for clay loam)	1.5 [5]
Bww=	**31.66**
Amonia Emissions kg NH_3/ha | AE= 2% * N (kg/ha) [6]	
AE=	**4.37**
Nitrous Oxide emissions due to fertilisers (kg N20-N/ha) = 1 + 0.0125 * N application (kg N/ha) (minus the N emitted through NH_3, as these predominantly occur earlier than the NO_2 emissions [6]	
N application =	175.4
N_2O-N emissions kg/ha =	**3.2**
NO_2 emissions kg/ha =	**5.0**
Phosphorous emissions to surface water or PE= 0.10 * P (kg/ha) [7]	
P_2O_5 (kg/ha)=	**0.07**
K emissions: According to UK assumption that surplus remains in the soil and there are no losses [8]	

CO_2 Emissions kg/ha

CO_2 carrier	Units of CO_2 carrier used	CO_2 Kg /Unit	CO_2/ha
Fuel kg/lt	71	3.6 [4]	255.6
N kg/kg (for production)	180	1.22 [8]	219.6
P kg/kg (for production of TSP)	322	2.995 [8]	966.129

Table A.5.6. Emissions to air/water/soil of fresh potato production (continued)			
K kg/kg (for production)	182.5	0.592 [8]	108.1
Total CO_2 Emissions			**1549.401**
SO_2 emissions kg/ha	Units of SO_2 carrier used	SO_2 Kg /Unit	SO_2/ha
Fuel kg/lt	71	0.007 [4]	0.497

Notes:

1. Data from J. Nix (1999).
2. Data from L. Chadwick (1999)
3. Data from J. Moerschner et al (1998).
4. Data from F. Leiva (1997).
5. Data from E. Audsley (1999).
6. Data from F. Brentrup et al (1998).
7. Data from J. Abdelsafae (1998).
8. Data from Audsley et al (1997).
9. Oil consumption consists of (l/ha): 25 for ploughing, 3 for fertiliser distribution, 21 for potato harvesting, 8 for potato planting, 1 for spraying and 13 for cultivation
10. For the Nitrate leaching function it was considered that the net annual drainage (D) can be taken as the annual rainfall less annual evapo-transpiration (about 440 mm for most crops in Eastern Counties of the UK). Most arable region in the UK are in the drier areas and have a mean annual rainfall of 500-700 mm.

Table A.5.7. Overall performance assessment of fresh potato production according to selected sustainability indicators

Sustainable Development Indicators	Total /ha of potato production	TOTAL /tonne ware potatoes	Total /tonne potatoes sold to consumers
Variable Costs £	1950	49.6	69.40
Fixed Costs £	675	17.2	24.02
Total Costs £	2625	66.8	93.42
Net Margin £	362.5	9.2	12.90
Gross Margin £	1037.5	26.4	36.92
Energy MJ	17707	450.6	630.15
Water consumption m^3	1400	1400	49.82
Pesticide Leaching (µg/l)	41.26	1.050	1.47
Nitrate leaching kg	31.7	0.806	1.13
Ammonia to air gr	4400	111	156.59
N_2O-N gr	3200	82	113.88
N_2O gr	5000	127	177.94
CO_2 to air kg	1549.4	39.42	55.14
SO_2 to air gr	500	12.6	17.79
P_2O_5 to surface water gr	70	1.7	2.49
Wastes		81	113
Labour hours	54	1.3740	1.92

Table A.5.8. Costs and profits at merchant stage

Costs (£/ tonne of fresh potatoes sold to retailer) (1)	
Variable Costs	
Raw Material (potatoes)	322
Packaging	23
Distribution	31
Labour	27.43
Rebate	7.35
Total Variable Costs	**410.78**
Total Variable Costs excluding raw material (but considering transportation)	**95.78**
Fixed Costs	46.5
Total Costs	457.28
Total Costs excluding raw material	142.28
Sales Price	294
Gross Margin	-116.78
Net Margin	-163.28
Notes:	
1. These data are refer to a particular month and to fresh White Potatoes packed in 2.5 kg bags, which accounted for a significant proportion of fresh potato sales to major retailers.	
2. Transportation cost is included in raw material (potatoes) cost and it is estimated to be around 7 £/tonne	
3. Merchants paid initially 230 £/tonne of bought potatoes, but given that waste ratio was on average 28.5%, it was 322 £/tonne of sold potatoes	
Table A.5.8. Costs and profits at merchant stage (continued)	
4. Fixed costs include plant and box depreciation, wages of permanent personnel, various bills, etc.	
5. For retailers marketing purpose some 'lines' (e.g. 2.5 kg Whites, 1 kg New Baby, 5 kg Baker) may have negative net margins for some period of time, however, the annual overall business financial revenues is usually positive	

Table A.5.9. Energy and water consumption at merchant stage

Water Consumption (m^3/sold tonne potatoes) (1)	**0.9 (1)**
Energy (MJ/tonne)	
Electricity (MJ/tonne)	282.53 (1, 2)
Fuel (MJ/tonne)	277.12 (3)
Total Energy (MJ/tonne)	**559.65**
Notes:	
1. 69724 tonnes were sold from that site in 1999. Annual water consumption was 44844 cubic meters in 1999. However, 71.5% of washed potatoes are sold to major retailers.	
2. Electricity annual consumption was 5,472,000 KWh or 19,699,200 MJ	
3. The average fuel (oil) consumption is 0.5 lt/mile (6). Moreover, 1 lt of oil has 43.3 MJ of energy (5), 25 tonnes are the average lorry load and food miles are 320.	

Table A.5.9. Energy and water consumption at merchant stage (continued)
4. Each lorry is assumed to bring 25 tonnes of potatoes. Lorry typically travels 30 miles to bring potatoes to the packhouse (on average) and 130 miles to deliver them packed to the retailer. However, lorries do not deliver any potatoes on their way back to packhouse, thus, the food miles considered in this study are 320. The ratio of fresh potatoes sold to retailers/purchased from farmers is 71.46%.
5. Data from F. Leiva (1997) Mechanisation for sustainability in arable farming. PhD thesis
6. Data from Volvo website: http://www9.volvo.com/truck/customeroffer/epd/pdf/epd_en01.pdf for Volvo FH12, Euro 3, MK1, in long-haul service. However, emissions to air may vary a lot depending on the load, the driving technique, speed and tyre pressure.

Table A.5.10 Wastes at merchant stage

Wastes of fresh potatoes (kg/ tonne of purchased potatoes)	**285**
Wastes of fresh potatoes (kg/ tonne of potatoes sold to retailers)	**399**
The weight of packaging materials was not estimated, as it was small. The weight of soil was also not of significant value	

Table A.5.11. Labour requirements and personnel training at merchant stage

		Labour (hours/tonne sold potatoes) on selected activities	
Total Labour (hours employed/year)	874000	Fork lifts	0.051
Tonnes of fresh potatoes sold per year	69724	Grading	0.275
Total Labour (hours/tonne sold potatoes)	**12.54**	Packing	1.82
Personnel training (hours/employee/year)	**48**	Total Transportation	0.34
		SubTotal	*2.49*

Notes:
1. 2 forklifts (drivers) work every day to handle 400 tonnes fresh potatoes
2. 3 employees grade 12-16 tonnes fresh potatoes per hour.
3. 2 graders at the top, 1 operator, 2 packers and 1 stacker work in each packaging line plus 1 QA person for every 2 lines. 7 packaging lines pack 200 tonnes/day.
4. Lorry drivers work (drive) 30 miles to bring potatoes to the packhouse (on average) and 130 miles to deliver them packed to the retailer. However, lorries do not deliver any potatoes on their way back to packhouse, thus, the food miles considered in this study are 320. The ratio of fresh potatoes sold to retailers/purchased from farmers is 71.46%.
5. 330 permanent and 50 temporary employees work on average 10 hours/day for 230 days per year
6. Personnel training is very important issue for the whole supply chain and merchant's stage is not exception. However, there is no measurement of this indicator by any merchant or retailer or farmer. Personnel's training is made to meet the legal requirements and to adapt to the everyday changes of the supply chain. According to the marketing manager of this case study business a very rough estimate is that on average every employee is trained at least 1 hour/week, although there is great variation on the level, duration and frequency of training according to the position of each employee.

Table A.5.12. Emissions to air at merchant stage

CO_2 kg/tonne sold potatoes			
Elements causing CO_2	**Units**	**Kg of Co_2 /unit**	**kg CO_2/tonne sold potatoes**
Electricity used (MJ/tonne sold potatoes)	282.5311 [5]	0.134 [2]	37.86
Food miles (oil used)	320 [1]	0.0521 [1,3]	16.67
Total CO_2 kg/tonne sold potatoes			54.53
SO_2 kg/tonne sold potatoes			
Elements causing SO_2	**Units**	**Kg of SO_2/unit**	**kg SO_2/tonne sold potatoes**
Electricity used (MJ/tonne sold potatoes)	282.5311 [5]	0.00067 [2]	0.189
Total SO_2 kg/tonne sold potatoes			0.189
NO_x kg/tonne sold potatoes	**Units**	**Kg of NO_x /unit**	**kg NO_x /tonne sold potatoes**
Food miles	320 [1]	0.000341 [1,3]	0.109

Notes:

1. Each lorry is assumed to bring 25 tonnes of potatoes. Lorries travel 30 miles to bring potatoes to the packhouse (on average) and 130 miles to deliver them packed to the retailer. However, lorries do not deliver any potatoes on their way back to packhouse, thus, the food miles considered in this study are 320. The ratio of fresh potatoes sold to retailers/purchased from farmers is 71.46%.

2. Data from Audsley et al (1997).

3. Data from Volvo website: http://www9.volvo.com/truck/customeroffer/epd/pdf/epd_en01.pdf for Volvo FH12, Euro 3, MK1, in long-haul service. However, emissions to air may vary a lot depending on the load, the driving technique, speed and tyre pressure.

4. Refrigerants' emissions were sought to be calculated, however, relevant data could not be obtained.

5. From A.5.9 Table on Water and Energy consumption at merchant stage

Table A.5.13. Overall performance assessment at merchant stage according to selected sustainability indicators

	Total/tonne sold potatoes
Variable Costs (£)	410.78
Variable Costs excluding raw material (£)	95.78
Fixed Costs (£)	46.5
Total Costs (£)	457.28
Total Costs excluding raw material (£)	142.28
Gross Margin (£)	-116.78
Net Margin (£)	-163.28
Energy (MJ)	559.65
Water consumption (cub. meters)	0,9
Refrigerants to air	No data
CO2 to air (kg)	54.53
SO2 to air (gr)	189
NO_x to air (gr)	109
Wastes (kg)	399
Labour (hours)	12.54
Personnel training (hours/employee/year)	48

Table A.5.14. Energy and water consumption at retail stage

Energy MJ/tonne sold potatoes			
Energy carrier	**Units**	**MJ/Unit**	**MJ**
Energy consumption at store			103.2 [1,2]
Fuel for transportation (miles)	50 [3]	1.732 [4,5]	86.6
Total Energy MJ/tonne sold potatoes			189.8

Notes:

1. Sell space for 1 tonne of fresh potatoes (daily) is estimated to be 65 sq feet by the fresh vegetables manager of the supermarket.

2. Tesco (2001) reported that 161 Kilowatt of energy /sqft sell area/pa was consumed on average at store. There is some variation on the energy needed by each food product at the stores. Fresh potatoes require less energy than frozen meet, for example, but more energy than past or rice, because fresh potatoes are stored at the 4° Celsius room until disposed for sell. Energy is also consumed at the distribution centre where potatoes are usually stored for a day.

3. Average distance between depot and store is 50 miles, thus round trip is 100 miles.

4. The average fuel (oil) consumption is 0.5 lt/mile [6]. Moreover, 1 lt of oil has 43.3 MJ of energy [5],25 tonnes are the average lorry load and food miles are 100.

5. Data from F. Leiva (1997) Mechanisation for sustainability in arable farming. PhD thesis

6. Data from Volvo website: http://www9.volvo.com/truck/customeroffer/epd/pdf/epd_en01.pdf for Volvo FH12, Euro 3, MK1, in long-haul service. However, emissions to air may vary a lot depending on the load, the driving technique, speed and tyre pressure.

7. It was considered that no water consumption is required for fresh potatoes at retail stage.

Table A.5.15. Wastes at retail stage

Wastes of fresh potatoes (kg/ tonne of purchased potatoes)	**5**
0.5% of purchased potatoes.	

Table A.5.16. Labour requirements and personnel training at retail stage

Labour hours/tonne sold potatoes	
Display &Sell	2
Transportation	0.1
Total Labour hours/tonne sold potatoes	2.1
Personnel training (hours/employee/year)	45
Notes:	
1. 2 hours of labour is spent for each tonne fresh potatoes sold (only 0.5% wastes) in order to bring them from the storage room to the sales area, unpack, keep an eye continuously if they have to remove the product and remove the packaging materials.	
2. For the transportation it is considered that the average distance between depot and store is 50 miles, the lorry returns without any product (only some packaging material for recycling), the average speed is 40 mph and the lorry capacity is 25 tonnes.	
3. No data related to labour hours/tonne sold potatoes could be obtained from the depot	
4. All employees are trained on average 1 hour per week for waste handling, sales and consumer satisfaction. This training refers to all product lines of the store and not only fresh potatoes	

Table A.5.17. Emissions to air at retail stage

CO_2 kg/tonne sold potatoes			
CO_2 carrier	**Units**	**Kg/Unit**	**Kg**
Energy consumption			7.82
Fuel for transportation			1.73
Total CO_2 kg/tonne sold potatoes			9.55

Table A.5.17. Emissions to air at retail stage (continued)

NO_x kg/tonne sold potatoes	**Units**	**gr/Unit**	**gr**
Fuel for transportation (miles)	100 [5]	0.341 [4,5]	34
Notes:			
1. Sell space for 1 tonne of fresh potatoes (daily) is estimated to be 65 sq feet by the fresh vegetables manager of the supermarket.			
2. Sainsbury (2001) reported that 573,200 tonnes of CO_2 were emitted from Sainsbury's stores (energy consumption) and 126,500 from transportation (product deliveries) during the year 1999/2000. The total sales area was 13,055,000 square feet at the same year. However, There is some variation on the energy needed by each food product. Moreover, it is not clear if the energy consumed at the distribution centre is also included.			
3. Refrigerant emissions were not calculated. Sainsbury (2001) reported that the following refrigerants were held in Sainsbury's supermarkets during 1999-2000: 3.03 tonnes of CFC; 601 tonnes of HCFC; 275 tonnes of HFC; and 0.58 tonnes of Ozone benign refrigerants. The total sales area was 13,055,000 square feet at the same year.			

Table A.5.17. Emissions to air at retail stage (continued)
4. Data from Volvo website: http://www9.volvo.com/truck/customeroffer/epd/pdf/epd_en01.pdf for Volvo FH12, Euro 3, MK1, in long-haul service. However, emissions to air may vary a lot depending on the load, the driving technique, speed and tyre pressure.
5. Average distance between depot and store is 50 miles, thus lorry has to be used for 100 miles to transport 25 tonnes of potatoes.

Table A.5.18. Overall performance assessment at retail stage according to selected sustainability indicators

	Total/tonne sold potatoes
Variable Costs (£)	
Variable Costs excluding raw material (£)	
Fixed Costs (£)	
Total Costs (£)	
Total Costs excluding raw material (£)	
Gross Margin (£)	
Net Margin (£)	
Energy (MJ)	189.8
Water consumption (cub. meters)	0
Refrigerants to air	
CO2 to air (kg)	9.55
SO2 to air (gr)	
NO_x to air (gr)	34
Wastes (kg)	5
Labour (hours)	2.1
Personnel training (hours/employee/year)	45

Table A.5.19. Supply chain performance according to selected indicators for 1 tonne of fresh potatoes sold to consumers

	FARMER	MERCHANT	RETAILER
Variable Costs (incl. raw material for merchants) £		411	
Variable Costs (excl. raw material for merchants) £	69	96	
Fixed Costs £	24	47	
Total Costs (incl. raw material for merchants) £		457	
Total Costs (excl. raw material for merchants) £	94	142	
Net Margin £	12.9	-117	
Gross Margin £	36.9	-163	
Energy MJ	630	560	190
Water consumption m^3	49.8	0.9	0
Pesticide Leaching (µg/l)	1.5		
Nitrate leaching kg	1.1		
Ammonia to air gr	157		
N2O-N gr	114		
N2O gr	178		
CO2 to air kg	55.1	54.5	9.6
SO2 to air gr	17.8	189	
P2O5 to surface water kg	2.5		
NO_x to air gr		109	34
Wastes (kg of fresh potatoes)	113	399	5
Labour hours	1.9	12.5	2.1
Personnel training (Hours/employee/year)		48	45

APPENDIX 6

TABLES FROM FARMERS' PERCEPTIONS OF SUSTAINABILITY

Table A.6.1 Frequencies statistics of the importance of factors influencing farmer decisions on potato enterprise management

	Valid Percent of Importance				
	Not at all	Little	Moderately	A lot	Extremely
2000 Profitability			0.4	14.2	85.4
1990 Profitability			10.1	32.4	57.6
2000 Climate	1.3	7.9	28.9	48.1	13.8
1990 Climate	5.9	17.6	37.8	30.3	8.4
2000 Land and Soil Quality		0.4	9.2	56.3	34
1990 Land and Soil Quality	0.4	5.1	38.5	42.3	13.7
2000 Water for Irrigation	12.2	5.5	22.7	29.4	30.3
1990 Water for Irrigation	19.1	15.7	28	24.2	13.1
2000 Environmental Risk	2.5	11.7	44.4	31	10.5
1990 Environmental Risk	13.9	43	35.4	5.5	2.1
2000 Personnel Management	2.5	5.4	24.3	45.2	22.6
1990 Personnel Management	3.8	15.7	47	25.8	7.6
2000 Relationships with SC		1.7	12.1	45.4	40.8
1990 Relationships with SC	2.5	19.7	47.5	20.2	10.1
2000 Business Uncertainty	1.3	4.6	28.6	45	20.6
1990 Business Uncertainty	4.2	31.8	44.5	15.3	4.2
2000 Market Requirements			5.5	47	47.5
1990 Market Requirements	1.3	13.9	50.6	24.1	10.1
2000 Food Product Safety and Quality		2.5	18.8	45.6	33.1
1990 Food Product Safety and Quality	5.5	30	41.4	18.6	4.6
2000 Community and Local Interests	7.9	26.8	38.9	21.8	4.6
1990 Community and Local Interests	20.3	31.2	37.1	8	3.4
2000 Use of New Technologies		5.8	30.4	50	13.8
1990 Use of New Technologies		8.4	45.8	38.7	7.1

Table A.6.2. Frequencies statistics of the importance of groups or organisations influencing farmer decisions on potato enterprise management

	Valid Percent of Importance				
	Not at all	Little	Moderately	A lot	Extremely
2000 Merchants		0.4	5.1	37.7	56.8
1990 Merchants	1.7	8.1	33.2	38.3	18.7
2000 Retailers	9.1	6.1	17	32.6	35.2
1990 Retailers	8.8	14.9	38.2	28.1	10.1
2000 Consumers	3.8	5.1	17.3	39.7	34.2
1990 Consumers	3.8	18.7	44.3	24.3	8.9
2000 Farm Advisor/Consultant	4.2	8	24.9	47.7	15.2
1990 Farm Advisor/Consultant	10.2	17.4	36.6	26	9.8
2000 Family	11.9	22.1	28.5	25.5	11.9
1990 Family	18.4	20.5	34.6	18.4	8.1
2000 Other Farmers	13.6	34.9	38.3	11.1	2.1
1990 Other Farmers	20.2	37.3	35.2	6	1.3
2000 Local Community	27.4	32.9	29.1	7.7	3
1990 Local Community	36.8	35.9	21.8	3.8	1.7
2000 Regulatory Authorities	7.2	20.3	37.6	27.4	7.6
1990 Regulatory Authorities	21.6	46.6	23.7	5.9	2.1
2000 Research Institutions	8.9	21.5	46	20.3	3.4
1990 Research Institutions	18.3	31.1	37	11.9	1.7
2000 Conservation Organisation	12.7	30.1	40.3	13.6	3.4
1990 Conservation Organisation	48.7	33.9	14	2.1	1.3
2000 British Potato Council	12.7	29.5	38.8	16	3
1990 British Potato Council	11.5	26.8	38.7	17.9	5.1
2000 Farmer Organisations	22	37.3	29.7	9.3	1.7
1990 Farmer Organisations	30.1	34.3	26.3	7.2	2.1
2000 Potato Grower Association	25	24.6	28	18.1	4.3
1990 Potato Grower Association	36.4	27.3	27.7	6.1	2.6

Table A.6.3 Frequencies statistics of the importance of factors limiting the performance of farm potato enterprise

	Valid Percent of Importance				
	Not at all	Little	Moderately	A lot	Extremely
2000 Quality of Labour Force	13.1	26.6	21.5	26.2	12.7
1990 Quality of Labour Force	10.8	33.2	32.8	18.5	4.7
2000 Land and Soil Quality	0.8	9.3	21.5	40.5	27.8
1990 Land and Soil Quality	0.9	22.5	41.6	21.2	13.9
2000 Water for Irrigation	10.6	16.5	22	29.7	21.2
1990 Water for Irrigation	17.8	20.4	29.6	19.6	12.6
2000 Climate	2.5	10.1	38.8	34.6	13.9
1990 Climate	9.1	23.8	42.9	16.5	7.8
2000 Relationships with Packers	3.8	16.5	22.9	34.7	22
1990 Relationships with Packers	4.8	30.9	36.1	23	5.2
2000 Relationships with Retailers	11.7	23.9	26.5	23.9	13.9
1990 Relationships with Retailers	11.8	37.1	29.4	19	2.7
2000 Information about Market Needs	5.9	29.7	28.4	29.2	6.8
1990 Information about Market Needs	11.3	38.1	33.3	14.7	2.6
2000 Financial Resources	8.5	16.5	22	30.9	22
1990 Financial Resources	13	23.5	35.7	18.7	9.1
2000 Variability of Potato Quality	0.4	8.5	25.8	33.1	32.2
1990 Variability of Potato Quality	0.9	21.2	41.1	29.9	6.9
2000 Variability of Potato Quantity	1.3	20.9	36.3	27.8	13.7
1990 Variability of Potato Quantity	2.6	24.3	35.2	33.5	4.3
2000 Variability of Potato Price	1.3	3.8	16.5	36.9	41.5
1990 Variability of Potato Price	2.6	11.3	30.9	34.3	20.9
2000 Availability of Advice and Technical Expertise	11.9	32.6	28	21.2	6.4
1990 Availability of Advice and Technical Expertise	8.7	32.6	42.2	14.8	1.7
2000 Availability of Technology	7.7	32.1	32.1	22.2	6
1990 Availability of Technology	7	34.5	35.8	20.5	2.2

Table A.6.4. Correlations between the size of the potato enterprise and other farmer characteristics

	Correlation Coefficient
2000 Land and Soil Quality	.157(*)
2000 Market Requirements	.135(*)
2000 British Potato Council	-.118(*)
2000 Water for Irrigation	.119(*)
Relationships with Merchants Improved	.156(**)
Potatoes are of Higher Quality	.155(**)
Knowledge of Market Needs Improved	.121(*)
Irrigation Management Improved	.134(*)
Employees Skills Improved	.125(*)
Financial Benefits Exceed Costs from Skills Improvement	.143(*)
Deregulation Has Been a Good Thing	.325(**)
Proportion of Potatoes Supplied to Retailers	-.165(**)
Proportion of Potatoes Supplied for Fresh	-.204(**)
Proportion of Potatoes Supplied for Processing	.158(**)
Applying Farm Assurance Scheme	-.195(**)
Staff Development/Training Scheme	-.226(**)
Participation in Potato Growers Association	-.277(**)
Increased Investment on Irrigation	-.286(**)
Increased Investment on Harvesting Systems	-.179(**)
Increased Investment on Grading	-.170(*)
Increased Investment on Storage	-.289(**)
Increase Economies of Scale or Specialisation	.393(**)
*Correlation is significant at the .05 level (2 tailed).	
** Correlation is significant at the .01 level (2 tailed).	

Table A.6.5. Correlations of participation in conservation scheme with other farmer characteristics

	Correlation Coefficient
2000 Information about Market Needs	-.123(*)
Environmental Pollution Risk Reduced	-.198(**)
Employees Skills Improved	-.161(**)
Financial Benefits Exceed Costs from Skills Improvement	-.166(**)
Improving Skills Benefits Environment	-.173(**)
British Potato Producers Focus on Local Market	-.380(*)
*Correlation is significant at the .05 level (2 tailed).	
** Correlation is significant at the .01 level (2 tailed).	

Table A.6.6. Correlations of carrying out environmental audit with other farmer characteristics

	Correlation Coefficient
2000 Market Requirements	-.167(**)
2000 Consumers	-.148(*)
2000 Variability of Potato Quantity	.140(*)
Land & Soil Management Improved	-.120(*)
Environmental Pollution Risk Reduced	-.148(*)
*Correlation is significant at the .05 level (2 tailed).	
** Correlation is significant at the .01 level (2 tailed).	

Table A.6.7. Correlations of adoption of elements of precision farming technology with other farmer characteristics

	Correlation Coefficient
2000 Variability of Potato Quality	-.154(*)
Relationships with Employees Improved	-.130(*)
Relationships with Local Community Improved	-.171(**)
Irrigation Management Improved	-.190(**)
Employees Skills Improved	-.145(*)
Increase Adoption of Advanced Technology	-.391(*)
*Correlation is significant at the .05 level (2 tailed).	
** Correlation is significant at the .01 level (2 tailed).	

Table A.6.8. Correlations of existence of staff development scheme with other farmer characteristics

	Correlation Coefficient
2000 Market Requirements	-.155(*)
2000 Community and Local Interests	-.119(*)
2000 Conservation Organisation	-.127(*)
Relationships with Merchants Improved	-.129(*)
Relationships with Employees Improved	-.165(**)
Use of IT Increased	-.149(*)
Environmental Pollution Risk Reduced	-.140(*)
Employees Skills Improved	-.271(**)
Financial Benefits Exceed Costs from Skills Improvement	-.206(**)
Improving Skills Benefits Environment	-.144(*)
Increase Economies of Scale or Specialisation	-.316(*)
Competition in Britain from Global Sourced Potatoes More Intense	-.336(*)
*Correlation is significant at the .05 level (2 tailed).	
** Correlation is significant at the .01 level (2 tailed).	

Table A.6.9. Correlations of participation in potato growers association with other farmer characteristics

	Correlation Coefficient
2000 Water for Irrigation (Q1)	-.156(**)
2000 Academic/Research Institutions	-.137(*)
2000 Conservation Organisation	-.132(*)
2000 British Potato Council	-.125(*)
2000 Potato Grower Association	-.397(**)
2000 Availability of Technology	-.131(*)
Knowledge of Market Needs Improved	-.152(*)
Irrigation Management Improved	-.226(**)
Employees Skills Improved	-.127(*)
Improving Skills Benefits Environment	-.137(*)
Deregulation Has Been a Good Thing	-.170(**)
Improve Land and Soil Management	.329(*)
*Correlation is significant at the .05 level (2 tailed).	
** Correlation is significant at the .01 level (2 tailed).	

Table A.6.10. Correlations of increased investment on irrigation and other farmer characteristics

	Correlation Coefficient
2000 Water for Irrigation (Q1)	-.552(**)
2000 Water for Irrigation (Q5)	-.127(*)
Irrigation Management Improved	-.568(**)
*Correlation is significant at the .05 level (2 tailed).	
** Correlation is significant at the .01 level (2 tailed).	

APPENDIX 7

TABLES FROM MERCHANTS PERCEPTIONS OF SUSTAINABILITY

Table A.7.1. Frequencies statistics of the importance of factors influencing merchant decisions on potato business management

	Valid Percent of Importance				
	Not at all	Little	Moderately	A lot	Extremely
2000 Profitability			5.9	11.8	82.4
2000 Natural Resources Management		5.9	5.9	52.9	35.3
2000 Environmental Risk				47.1	52.9
2000 Personnel Management			11.8	82.4	5.9
2000 Business Uncertainty			17.6	41.2	41.2
2000 Relationships with SC				58.8	41.2
2000 Market Requirements			5.9	47.1	47.1
2000 Food Product Safety and Quality			5.9	35.3	58.8
2000 Community and Local Interests			52.9	47.1	
2000 Use of New Technologies			17.6	64.7	17.6
1990 Profitability			5.9	52.9	41.2
1990 Natural Resources Management	6.3	37.5	31.3	18.8	6.3
1990 Environmental Risk	5.9	29.4	41.2	23.5	
1990 Personnel Management		5.9	70.6	23.5	
1990 Business Uncertainty		5.9	35.3	47.1	11.8
1990 Relationships with SC			23.5	58.8	17.6
1990 Market Requirements			47.1	35.3	17.6
1990 Food Product Safety and Quality		11.8	41.2	35.3	11.8
1990 Community and Local Interests	5.9	29.4	58.8	5.9	
1990 Use of New Technologies	5.9	11.8	41.2	35.3	5.9

Table A.7.2. Frequencies statistics of the importance of groups or organisations influencing merchant decisions on potato business management

	Valid Percent of Importance				
	Not at all	Little	Moderately	A lot	Extremely
2000 Retailers	5.9		5.9	5.9	82.4
2000 Growers			5.9	76.5	17.6
2000 Consumers			17.6	47.1	35.3
2000 Advisor/Consultant	17.6	17.6	52.9	11.8	
2000 Other Suppliers/Packers		5.9	64.7	29.4	
2000 Local Community	5.9	11.8	64.7	17.6	
2000 Regulatory Authorities		5.9	17.6	58.8	17.6
2000 Research Institutions		41.2	52.9	5.9	
2000 NG Environmental Organisations	11.8	29.4	52.9		5.9
2000 Consumer Organisations	25	25	50		
2000 British Potato Council		29.4	52.9	17.6	
2000 Packers Organisation	17.6	35.3	41.2	5.9	
1990 Retailers			5.9	52.9	41.2
1990 Growers			41.2	47.1	11.8
1990 Consumers		17.6	41.2	35.3	5.9
1990 Advisor/Consultant	23.5	58.8	17.6		
1990 Other Supplier/Packers		23.5	58.8	17.6	
1990 Local Community	11.8	41.2	29.4	17.6	
1990 Regulatory Authorities	11.8	52.9	17.6	17.6	
1990 Research Institutions	17.6	64.7	17.6		
1990 NG Environmental Organisations	29.4	52.9	17.6		
1990 Consumer Organisations	23.5	58.8	17.6		
1990 British Potato Council		29.4	52.9	17.6	
1990 Packers Organisations	11.8	23.5	47.1	17.6	

Table A.7.3. Frequencies statistics of the importance of factors limiting the performance of merchant potato business

	Valid Percent of Importance				
	Not at all	Little	Moderately	A lot	Extremely
2000 Quality of Labour Force	11.8	5.9	41.2	29.4	11.8
2000 Relationships with Retailers		11.8	41.2	35.3	11.8
2000 Relationships with Growers	5.9	23.5	35.3	35.3	
2000 Information about Market Needs	11.8	17.6	58.8	11.8	
2000 Financial Resources	17.6	17.6	47.1	11.8	5.9
2000 Variability of Potato Quality	5.9	5.9	35.3	29.4	23.5
2000 Availability of Potato Quantity	5.9	29.4	17.6	35.3	11.8
2000 Variability of Potato Price	5.9	11.8	35.3	41.2	5.9
2000 Availability of Technology	11.8	23.5	52.9	11.8	
1990 Quality of Labour Force	11.8	41.2	23.5	23.5	
1990 Relationships with Retailers			47.1	41.2	11.8
1990 Relationships with Growers	11.8	17.6	52.9	17.6	
1990 Information about Market Needs	11.8	23.5	41.2	23.5	
1990 Financial Resources	29.4	11.8	41.2	17.6	
1990 Variability of Potato Quality	5.9	11.8	35.3	41.2	5.9
1990 Availability of Potato Quantity	5.9	23.5	41.2	23.5	5.9
1990 Variability of Potato Price	5.9	17.6	35.3	41.2	
1990 Availability of Technology	11.8	17.6	52.9	17.6	